SUPPLEMENT

TO THE

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WATER SUPPLY, & SANITARY IMPROVEMENT.

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BRITISH ASSOCIATION OF GAS MANAGERS.

The Fifth Annual General Meeting of the Members of this Association was held in London on the 2nd, 3rd, and 4th of June, in the rooms of the Society of Arts, John Street, Adelphi, which had been kindly lent for the occasion by the Council of the Society. There was a large attendance of members and visitors at each of the sittings. The proceedings commenced on

TUESDAY, JUNE 2,

at eleven o'clock, when THOS. G. BARLOW, Esq., C.E., the president of the association, took the chair.

Mr. JAMES BLACKBURN, of Droylsden, the honorary secretary, read the minutes of the last annual assembly at Nottingham, which were approved.

The financial statement of the association, having been printed and circulated, was taken as read, and, on the motion of the PRESIDENT, was received and adopted.

The following gentlemen were elected members of the association during its sittings:—

ORDINARY MEMBERS.

Anderson, T., Gas-Works, Bath.
Backler, H. M'L., 4, Frederick's Place, Old Jewry, London, E.C.
Baker, E., Gas-Works, Reading.
Ball, John B., Gas-Works, Yeovil.
Binks, J., Gas-Works, Gomersall, near Leeds.
Carpenter, W. T., Gas-Works, Sheerness.
Clarke, David, Gas-Works, Hendon, Sunderland.
Cocker, J. L., Gas-Works, Merthyr Tydfil.
Darney, R., Gas-Works, Faversham.
Davis, W., Gas-Works, Canterbury.
Douglas, T., Gas-Works, Barnet.
Everist, H. T., Gas-Works, Kidderminster.
Ford, G. M., Gas-Works, Falmouth.
Ford, W., Gas-Works, Newry, Ireland.
Forrest, T., Gas-Works, Walker, near Newcastle-on-Tyne.
Foster, C., Gas-Works, Belper, near Derby.
Helps, Daniel, Gas-Works, Bath.
Hepworth, J., Gas-Works, Brighouse.
Hersee, A., 127, Leadenhall Street, London, E.C.
Johnson, J., Chartered Gas Compy., [London.
Kirkham, Thomas N., Imperial Gas Company, Fulham.
Laycock, J., Gas-Works, Keighley.
Livesay, A. F., 30, Penny Street, Portsmouth.
May, T., Gas-Works, Ramsgate.
M'Niel, A., Gas-Works, Tiverton, Devon.
Morris, Joseph, Gas-Works, Jersey.
Parlby, W., Gas-Works, Chepstow.
Pearson, T., Gas-Works, Portland.
Price, E., Gas-Works, Hampton Wick.
Read, Charles, Gas-Works, Congleton.
Reed, J., Gas-Works, Newport, Isle of Wight.
Rich, James, Gas-Works, Devonport.
Slip, W. H., Gas-Works, Red Hill, Surrey.
Spice, R. Paulson, County Chambers, Cornhill, London.
Syms, William, Gas-Works, Rochester.
Thorman, E. H., Gas-Works, West Ham, Stratford, Essex.
Turney, A. R., Gas-Works, High Wycombe, Bucks.
White, T. W. R., Gas-Works, Sherborne.
Williams, A., 64, Bankside, London, S.
Wright, William, Gas-Works, Lewes.

HONORARY MEMBER.

Odling, William, M.B., F.R.S., London.

EXTRAORDINARY MEMBERS.

Aird, John, junr., Belvidere Road, Lambeth, S.E.
Cowen, John A., Blaydon Burn, near Newcastle-on-Tyne.
Walker, William Thomas, Donnington, near Newport, Salop.

The PRESIDENT then delivered the following

INAUGURAL ADDRESS.

Gentlemen,—On opening the business of the present session of your association, to which you have done me the honour to elect me as president, I have to bespeak your indulgence should I fail to discharge the duties of the office as efficiently as my distinguished predecessor, whose experience and aptitude for public business eminently qualify him for such a position. Nevertheless, I can assure you that, though I may be found deficient in those qualifications, I am equally zealous as he can be for the prosperity of the British Association of Gas Managers, and anxious to do all within my power to promote its success.

It becomes my duty in the first place, according to established practice, to bring before your notice the progress which has been made during the past year on the advancement of your association in the manufacture and distribution of gas, and to consider the position in which we stand in a scientific and a commercial point of view.

The continued increase in the number of the members of our association is the best proof that can be given of increasing interest in the improvement of the various manufacturing processes connected with the production of gas, and affords solid ground for hoping that gas lighting will ere long take a high position among the applied sciences. At the first session of the association, in 1864, the number of members amounted to only 92; at the second session the number was increased to 109; at the third, to 143; and at the fourth session, last year, at Nottingham, the number of members amounted to 177. We have since lost by death or otherwise 7 members; but 38 have been elected on the present occasion, which will raise the total number of members to 208. We have still to regret the absence of many of our London brethren, but it is to be hoped, now the success of the association is so firmly established, that they may be induced to join our ranks, in which they are sure to find a hearty welcome. The advantages to be derived from such meetings is no longer questionable. The parent institution—the British Association for the Advancement of Science—having triumphantly proved that the annual gathering together of those who are interested in similar pursuits not only tends to stimulate discovery and to disseminate information, but by bringing such men personally acquainted with one another, it enables them to interchange thoughts, and thus softens down asperities and produces harmony and concord. The increase of our numbers has, indeed, its inconvenience, inasmuch as it increases the difficulty of personal recognition, and it has been humorously suggested to me that each member should be numbered and ticketed, so that by reference to a catalogue it might be known "who's who." The committee have not yet taken action in the matter, and in the meantime I beg to recommend that each member who wishes to address the meeting should hand his card to the chairman as his "ticket-of-leave" to speak, and his name could then be distinctly announced. It is very desirable in our discussions that all variations of opinion should be expressed, therefore I hope that a large majority of members will present their "tickets-of-leave."

There is another suggestion which I wish to make more earnestly, as it relates to a benevolent object, towards the accomplishment of which the efforts of the association may be beneficially directed. We are most of us now in the vigour of life, but gas managers are not, any more than other men, exempt from "all the ills that flesh is heir to," and when associated together for the advancement of our common pursuit it seems to me an appropriate time to consider the means of providing for the relief of the probable wants of the future. The creation of a gas managers benefit fund for the relief of deserving members who may be incapacitated by old age or sickness from discharging their duties, is, I conceive, a subject justly deserving the attention of our association. Several of the metropolitan and larger provincial gas companies have instituted such means for relieving their officers when incapable of work, and if it be thought fit to adopt my suggestion I am willing to contribute substantially for the foundation of such a fund.

Gentlemen, in considering the progress that has been made in the manufacture and distribution of gas during the past year, the new inventions and new processes which have been adopted or tried with prospect of success deserve to be especially noticed. Foremost among them is M'Kenzie's process for producing gas of high illuminating power from small coal mixed with crude shale oil. The pressure which the Legislature has recently put on gas companies to raise the standard of illuminating power considerably above that obtainable from common coal has compelled most of them to use a certain proportion of cannel coal at a heavy cost and with a diminution in the value of the coke. The advance in the price of cannel consequent on the increased consumption has stimulated inquiry to find a substitute for it, and this seems to have been accomplished by Mr. M'Kenzie, whose process has been successfully adopted on a large scale at the Alliance Gas-Works, in Dublin. The small coal is well mixed with the oil in the proportions varying from 10 to 30 gallons of oil to 1 ton of coals. This is effected by means of a mixing or grinding mill. The compound material is then distilled in ordinary gas-retorts of clay or iron at a strong heat approaching a white heat. I have recently witnessed an experiment on a mixture of Llantwit small coal shipped at Cardiff, and costing in Dublin 12s. 6d. per ton, with 5 per cent. of Broxbourne shale oil, costing £5 10s. per ton, the produce of the distillation of one ton of which mixture was

9750 cubic feet of gas of 21·5 candles illuminating power.
37 bushels of good hard saleable coke.
2 bushels of breeze.
11 gallons of tar.
15 gallons of ammoniacal liquor of 5° Twaddle.

The cost of this mixture, including royalty, was about 17s. per ton against 24s. for Wigan cannel, over which it has the advantage of at least 5s. per ton in the value of the coke.

Two other new sources of supply of materials for producing gas of high illuminating power have been proposed—viz., New Brunswick albertite and Trinidad bitumen. From the results of experiments on the former made by Mr. Evans, at the Horseferry Road works of the Chartered Company, it appears that the yield per ton is from 9166 to 10,200 cubic feet of gas, varying in illuminating power from 28·66 to 35·42 candles, from which quantity, however, 10 per cent. must be deducted in practical operations on a working scale, and the material is offered for sale in London at 37s. 6d. per ton. Trinidad bitumen does not present quite the same advantages. When mixed with 80 per cent. of Newcastle coal the yield per ton, according to the joint experiments of Dr. Letheby and Mr. Keats, was 10,600 cubic feet of 17·6-candle gas, and it could be sold in London at from 45s. to 50s. per ton. There is, however, the serious drawback to the use of Trinidad bitumen that it contains a large amount of sulphur and of water. These applications of shale oil and bituminous substances, more especially that of shale oil, afford reason to believe that the threatened difficulty arising from the scarcity of cannel consequent on the greatly increased demand may in some measure, if not entirely, be overcome.

My predecessor alluded in his inaugual address to the invention of mechanical appliances for the charging of retorts, by which a large system of retorts set in one oven might be charged at once, by a number of scoops operating at the same instant. That plan has since been practically tried at the Alliance Gas-Works, in Dublin, and I am able to speak of it very favourably. A new retort-house has been erected, capable of carbonizing 300 tons of coal in a day, and containing 270 double retorts, or 540 mouthpieces, the charging and discharging of which is performed by two machines, and hitherto with complete success. Best and Holden's "steam stoker," as the machine has been termed, appears to be destined to make a revolution

in the retort-house arrangements of all large gas-works that may be henceforward constructed. The inventors have obtained three patents for different applications of their machinery for charging retorts, some parts of which may be applied to small works. I recommend any engineer who is contemplating the erection of a large retort-house to examine the working of Messrs. Best and Holden's steam stoker at the Alliance Company's works. The company deliver the coals into a hopper at the top of the machine, and remove the coke from the stoke-hole, and the patentees have contracted for the charging and discharging of the retorts at the rate of 9d. per ton including royalty, the cost under the old system having been 1s. 7d.

Some modifications which have been made in the form and arrangements of the dip-pipe deserve to be mentioned, as they tend to remove the inconveniences that arise from the necessity of having the dip-pipe sealed in the hydraulic main. An American inventor has suggested an alteration in the old form of hydraulic main by casting the dip on its side, as shown in the diagram produced. This method of forming the dip-pipe presents some advantages in clearing out, and it avoids the inconvenience attending the collection of pitch round the mouths of the pipes. A more important arrangement of the dip-pipe, having for its object the removal of the pressure in the retorts occasioned by the seal in the hydraulic main, has been contrived by Messrs. Cockey and Sons. The necessity for relieving the retorts from that pressure was recognized in the early stages of the introduction of clay-retorts, and Spinney's contrivance for that purpose is, I believe, still in use in several gas-works. By the contrivance of Messrs. Cockey—a model of which is on the table—the pressure is entirely removed by the exhauster during the time the coal is being carbonized. This arrangement is called by the inventors a "telescopic" dip-pipe, that portion of it which enters the tar in the hydraulic main being made to slide up, like the tube of a telescope, as soon as the retort is charged; the action taking place by means of a lever to which a handle is attached. Before loosening the lid of the retort the telescopic part of the pipe is lowered again into the tar to prevent the gas from passing back into the retort.

Any improvement in construction of exhausters to produce increased steadiness and uniformity of action, is a desirable acquisition. Mr. C. Horsley's exhauster seems, in these respects, to deserve attention. It consists of an outer cylinder or case, with inlet and outlet attached, and an inner drum is placed eccentrically, so that one side of it is in contact with the cylinder. On to this inner drum three or more flaps or valves of wrought iron, extending its whole length, are hinged, forming, when closed, parts of the circumference of the drum. These valves are kept extended by centrifugal force, which is quite sufficient for that purpose, at the slowest rate of rotation when the exhauster is placed vertically. The advantages claimed by the inventor for this exhauster are that, should it be suddenly stopped, the valves open and form a complete self-adjusting relieving valve; the oscillation of the gauge is entirely prevented, and the seal of the dip-pipe is insured and is always the same. The power required to drive this exhauster is stated to be very small in comparison with others.

In the process of purification but little advance has been made. Experience, however, serves to confirm Dr. Letheby's opinion that the sulphur compounds in gas may be considerably reduced by dry-lime purifiers of large surface, through which the gas passes slowly. This has been shown to be the case at the Great Central Gas-Works, where the quarterly average of sulphur has by that means been reduced from nearly 30 grains to less than 20 grains per 100 cubic feet. A new process for ascertaining the remaining quantity of sulphur in gas has been proposed by Mr. Valentin, of the College of Chemistry, in which he burns the gas with an admixture of atmospheric air among pieces of spongy platinum and through platinum gauze. He claims for his instrument that it ensures a more perfect combustion than by any other, and that he is able, by the use of soda-lime, to arrest every atom of sulphur in the gas. Mr. Valentin objects to Dr. Letheby's test, that it fails to detect a considerable quantity of the sulphur contained in the gas; but in that opinion he is opposed by M. Ellissen, the chief of the experimental works of the Paris Gas Company, who contends that practically the Letheby test is as correct an instrument for ascertaining the quantity of sulphur contained in gas as can be desired. It is well observed by M. Ellissen that the only portion of the sulphur in gas that can be injurious to health or to property is that portion which is eliminated in the form of sulphurous acid during ordinary combustion, and that any laboratory test which by means not commonly adopted can extract a larger quantity of sulphur from the gas is, or ought to be, useless as a test of the purity of the gas supplied to the public.

In meters and gasholders there is no novelty to notice, the manufacturers vying with each other in producing the best article at the lowest cost rather than in further improvements in what is held to be perfection.

The joints for street-mains continue to offer a wide field for the exercise of ingenuity. Upon the table there is a model of an elastic joint, invented by Mr. W. Austin, which has been successfully tried in several places, and possesses decided advantages over the ordinary lead joint or the rigid turned and bored joint. The whole length of each pipe is perfectly cylindrical, without socket, and the ends of each are corrugated, to give a firmer hold to the elastic packing employed. In making a joint, a ring of flexible material is placed over the end of one pipe and an iron ring over the end of the other; the two pipes are then butted against each other, and the flexible ring is slipped over the junction and the iron ring is driven over the flexible one, both rings being made slightly conical, so that the iron ring may pass over the flexible one more easily at first, and act as a wedge in tightening the joint as it is driven in. For pipes larger than 10 inches in diameter, an iron collar, provided with bolts and nuts, is applied for drawing the conical iron ring over the flexible packing. The model of a lead joint, invented by a M. Farjon, is also on the table. It has been used for the whole of the mains of the Brussels Water-Works, for which use it is especially adapted on account of its great strength. It will be seen that the ends of each pipe are swelled out, and terminate with a groove and small flange. The joint is made, after placing the ends of two pipes together, by first covering the junction with a band of soft sheet lead, which is pressed into the grooves by means of an iron collar placed temporarily over it, and the ends of which are screwed tightly upon the lead. The collar is then removed, and an iron hoop is driven over the joint to keep the lead in its place. Finally, to increase the strength of the joint the soft metal round the hoop is hammered in. There is nothing actually novel in the principle on which these joints are made, for in the fourth edition of Clegg's "Treatise on Coal Gas" several similar joints are shown, but there is some difference in the method of applying the packing of elastic or soft metal bands which renders them deserving of notice, and Mr. Austin's joint possesses the advantage of being simpler and more readily applied.

A model of Warner's quadrant motion gas and water valve lies upon the table, and merits attention by its simplicity, efficiency, and economy.' In the construction of this valve, which is made of cast-iron, a segment piece, in conjunction with the disc which closes the main, turns on a centre at the top of the valve-case, which segment piece is constructed with teeth gearing with a worm cut on the spindle, the stem of which passes out of the valve-case through a stuffing-box, on which a wheel or handle is fixed. By this means the disc is drawn entirely out of the way, and an unobstructed passage is left through the main.

District dry gas governors supply a want that is much felt in the regulation of the pressure in districts of varying levels. The effect of the action of ordinary gas governors is to give a constant outlet with a variable inlet pressure. They are consequently inapplicable as district or supplemental governors, because as they require where so applied to give the maximum night pressure on their outlets, such pressure is necessarily maintained during the whole twenty-four hours. The requirements, therefore, of an efficient district governor are the opposite of those of the ordinary governor, for while the pressure at any given point can be reduced to the extent desired, the reduced pressure should be proportionately increased and diminished in accordance with the initial pressure. These conditions are fulfilled in the governor of Mr. Cathels, by the simple expedient of reversing the action of the ordinary governor, and suspending the cone above instead of under the opening, and by turning its apex downwards. Instead, therefore, of being drawn upwards and throttling the gas-way by increased inlet pressure, the cone is lifted farther from its seat, thus increasing the outward pressure; and in falling that pressure is diminished in proportion to the decrease of the pressure at the inlet. The pressure may be adjusted to any required degree by means of a counterpoise, and when once properly adjusted the governor is entirely self-acting, the outlet pressure being the governing power.

In photometry there is little novelty to record in the methods adopted for estimating with greater certainty the illuminating power of gas, but an important modification has been made, with the sanction of the House of Commons, in the kind of burner to be henceforth employed in such experiments. The committee on the metropolis gas bills recognized the right of gas companies to use the burner that will best develop the luminiferous properties of the gas, provided that it be one that can be practically adopted by the public—throwing overboard, in fact, the old 15-hole Argand burner and 7-inch chimney, with all their perplexing discrepancies. A most vexatious question has thus been set at rest, and an important principle, for which gas companies have long contended, has been established, which will form the basis of future estimations of the illuminating power of gas. I must not omit to mention, in connexion with this branch of my subject, an able paper on photometry recently read by our esteemed member Mr. Alfred H. Wood, before the Hastings Philosophical and Historical Society, which contains a lucid digest of the principles and practice adopted in determining the amount of light-giving power in gas.

An instrument on the table, called by the inventor a "gasograph," appears somewhat to contradict the assertion that there has been little novelty in photometry. It is the invention of Herr Friedleben, the director of the Offenbach Gas Works, in Germany, the object of it being to test the illuminating power of gas without any standard of comparison. It is similar in the principle of its construction to Lowe's jet photometer, and is intended to indicate the illuminating power of gas by the height of a flame burning from a jet under a constant pressure, and also by the height of a flame when the gas is mixed with atmospheric air. The instrument records upon paper the quantity of gas consumed during the time it is in use; but, unlike the registering jet photometer contrived by Messrs. Kirkham and Sugg, which was exhibited to you in 1866, it does not record the height of the flame, nor the pressure under which the gas is consumed.

Thanks to the perfection to which street-lamp regulators have been brought, the disputes between local authorities and gas companies have become much more rare, and they can now be more easily settled. It will be seen from the programme of our proceedings that Mr. Charles Hawksley will give us some information as to the success of the system of average meter indication since its application in Nottingham, where it has been for some time in operation, and has been found to give satisfaction.

The double tap, which was for some time in favour with local authorities, has fallen into disrepute, and the correctness of the action of the regulator as now manufactured renders such attempts to attain additional accuracy of measurement unnecessary. Even the local authorities of Folkestone, who seemed bent on the use of the double tap, with a meter fixed to every other lamp, have abandoned that proposition, and have had recourse to the regulator, with one meter to every twelfth lamp.

Two instruments have been invented for the purpose of lighting and extinguishing street-lamps by self-acting apparatus. One of these, the invention of Mr. Thurgar, a surgeon at Norwich, was exhibited at the last *conversazione* of the president of the Institution of Civil Engineers, and formed the subject of a paper recently read before the Society of Arts in this room. It consists of a clock-work arrangement which, by means of a wire lever or cam, turns on and shuts off the gas at any hour to which the dial may be set; a small regulated leakage, burning with a blue flame, being kept alight in the daytime to set fire to the gas when the tap is turned. A copper case surrounding the burner protects the small flame from being extinguished. Many practical difficulties would, however, prevent the application of this contrivance, one of which is the liability of the small tube which supplies gas in the daytime to be choked up with naphthaline, and the cost of the blue flame, though calculated to burn only a quarter of a cubic foot an hour, would amount to 7s. 7d. a year. There would also be the expense of supervision and of fresh application, which would render this automaton lamplighter more costly than a living one. The other apparatus is the invention of Mr. Price, a member of our Association, and may be inspected on the table. By this arrangement the gas is to be lighted by the change from night to day pressure, and to be extinguished by the reverse change of the pressure from that of night to that of day. In this contrivance also a blue flame is maintained burning during the day. Though both inventions are very ingenious, I fear that neither of them in their present condition is practically applicable.

An attempt has also been made to light the lamps in Hyde Park by electricity, but without success. The failure is attributed to causes that might have been avoided, but even had it been so far successful as to have lighted all the lamps instantaneously, it does not appear that the saving of time and of labour would have been equivalent to the cost, and the system does not present sufficient advantage to induce members of the association to endeavour to put it into practice in their districts. In certain circumstances, however, electric gas-lighters have been found useful. The lecture theatre of the Royal Institution has had an apparatus for lighting its sun-burner by electricity in successful action for two or three years, and in a recent number of the journal of the Franklin Institute it is stated that an electric lighter, invented by a Mr. Cornelius, is extensively used in private houses and in public buildings in Philadelphia. In his apparatus static electricity, excited by a vulcanite india-rubber plug introduced into a

vase, is employed on the principle of the electrophorus, by which a store of electricity is retained always ready to light the gas when required.

The attempts to increase the illuminating power of gas by the process of what is termed carburetting with the vapour of volatile oils have not hitherto been attended with much success; but a plan is now on trial at the Euston Square terminus of the North-Western Railway Company, of carburetting gas with the heavy oils of tar, according to a method patented by Messrs. Symes and Barff, which promises more favourably. The hall is lighted by two sun-burners, and the reservoir for the oil is placed above the lights. The gas enters at the top of the vessel on one side, and passes to the burners from an outlet on the opposite side, after traversing the vessel in contact with the oil. The pipe which conveys the gas to the burners is carried down an opening in the centre of the reservoir, through which the products of combustion escape, the under part of the reservoir being concave and polished to serve as a reflector. The heat of the burning gas disengages the naphtha vapours, which combine mechanically with the gas and are consumed at the burners, but to what extent the illuminating power of the gas is thus increased has not been satisfactorily determined. The employment of the heavy oil of tar renders the process less dangerous than when volatile oils are used for the purpose; nevertheless a trial of the plan at the Chartered Company's Gas-Works, by Mr. Evans, resulted in the destruction by fire of the experimental room in which the apparatus was fixed.

Our esteemed vice-president has rendered good service to gas companies by his exertions in utilizing gas tar in forming asphalte flooring, especially suitable for malt-houses, barns, corn-stores, cellars, yards, manufacturing workshops, stables, and thrashing-floors, which appear to have given satisfaction to all who have tried them. The moderate cost of the asphalte flooring ought to induce a large consumption of gas tar throughout the country, and enhance its market value.

The successful application of the explosive force of gas as a motive power opens an extensive field for the demand for gas for day consumption in manufacturing towns; and I cannot forbear expressing surprise that gas companies have not made more exertions to promote the use of the gas-engines. Improvements have been made on the original form of the Lenoir engine by Messrs. Kinder and Kinsey, by which its power and efficiency have been considerably increased, of which the members will have an opportunity of judging by visiting the works of the company, in Vine Street, Lambeth, at the termination of this morning's proceedings. They will there see one of the engines at work, and be enabled to test its power.

Some sensation has been produced in Paris by the introduction of a scheme for producing oxygen by the agency of sulphuric acid, to be applied for the purpose of illumination in combination with coal gas. The application of the oxygen was similar to that in the well-known lime light, which has been frequently tried in this country, with the substitution of magnesia for lime, the former being more capable of resisting the heat of the oxy-hydrogen jet. Elaborate experiments have been made at the Hôtel de Ville, under the superintendence of M. Alfond, the director of the public promenades, in which the illuminating power of the magnesia light was compared with gas; but the result, if not a failure, has not been a success, and the experiments have been discontinued.

Gentlemen, I believe I have now exhausted what I have to say on the progress made during the past year in appliances relating to the production and distribution of gas; I cannot, however, conclude this address without noticing the effect which recent legislation may have, not only on the supply of gas in London, but also in the provinces. Some important precedents have been established by the committee on the metropolis gas bills which may have a serious influence on the prosperity of all gas companies in future. It has been decided that the amount of all penalties is to be deducted from profits out of which dividends are to be declared, which penalties are to be imposed at the rate of 20s. for every 100,000 feet for each half candle of defective illuminating power below the standard; and the penalty for excess of impurity above the amount, to be prescribed by the gas referees, is to be £50 for each station in respect of which the company may be in default. Against the testing of the official examiner of the district there is to be only one appeal, and that is to the chief gas examiner, whose decision is to be final. The official tester may do his best to obtain fair and accurate results, but he will be, of course, liable to error; and it is difficult to see how the chief examiner can put him right, as it would be impossible to test the same gas again in the same day, and experiments of the official examiner are not to be interfered with. Whether it will be possible to work under such stringent regulations will depend entirely on the view taken of those duties by the gas referees to be appointed by the Board of Trade, on whom extensive powers are to be conferred that might be brought to bear very prejudicially on the interests of the gas companies.

It has been my desire, gentlemen, in the foregoing remarks, to give a practical turn to your deliberations, and to induce you to continue in the course of progress towards bringing the science and practice of gas lighting to perfection. I have felt much honoured and have had great satisfaction in addressing a body of men so distinguished for their intelligence as the gas managers of this country, feeling assured that your sound sense and excellent judgment will appreciate what might be deserving of your notice. I beg, in conclusion, to remind you that Dr. Odling will, at eight o'clock this evening, deliver his lecture "On Some of the Constituents of Coal Gas."

Mr. JAMES PATERSON, of Warrington, read the following paper:—

NOTES ON THE CANNEL COALS OF ENGLAND.

In the few remarks I venture to lay before you it is not my intention to enter upon the natural history of coal, as this may probably form the subject of a paper at a future time. I purpose, therefore, with your permission, to confine myself to a cursory view of the English cannels, so far as they are known to me; these, though somewhat limited in their geographical range, are so widely diversified in their characters as to render it a matter of difficulty, if at all practicable, to classify or arrange them into arbitrary groups or orders, and any attempt to do so would obviously be more or less objectionable. There are, however, certain external evidences, generally well defined, which, if properly studied, will enable the gas engineer, without the aid of analysis, to form a tolerably reliable estimate of their value, whether for gas or cooking purposes. These are—Cleavage, Fracture, Texture, Streak, and Weight. If breathed upon, and the cannel gives off a clayey odour, it contains an argillaceous base; if no odour be given off, the base is presumably carbonaceous. In the former case it is more or less destitute of coke (in the accepted sense of the term); the latter yields a coke, the quality of which may be approximately determined by the grain in the cleavage and fracture of the cannel. Upon these evidences I presume to base the following general classification, which may not be without its faults, but I venture to believe is probably less free from objections than that of any other method we could adopt, viz.:—

1. Those which present a *maximum* per centage of illuminating matter, and a *minimum* per centage of fixed carbon.
2. Those which present an *average* per centage of illuminating matter, and from an *average* to a *maximum* per centage of fixed carbon.
3. Those which present a *minimum* per centage of illuminating matter, and from an *average* to a *minimum* per centage of fixed carbon.

FIRST ORDER.

The *type* of the first order is that familiarly known to us under the name of Boghead, which is large, massive, and cubical. The lower portion presents a dull dark-brown colour, passing into black in the upper portion of the seam. When struck with a hammer, or scratched with the point of a nail, it leaves an impression from a dull brown to that of a brownish yellow colour, indicating a coal rich in hydrocarbons. When breathed upon, it gives out strongly the odour of its argillaceous base. Its average specific gravity is 1·204; one cubic foot, therefore, weighs 75·034 lbs.

Welsh Cannel.—I am not acquainted with any of the tertiary lignites, but I think it very probable that none of them would occupy a place in this division, and that the only counterpart of the Boghead in England is represented by the curly cannel in the palæozoic strata of North Wales. It is wrought at Coed Talon, Leeswood, and other places in the neighbourhood of Mold, and presents a sill from 4 to 5 feet thick, which will be described in the order of our arrangement. The chief value of this deposit is due to the curly cannel which occupies the centre of the bed, and varies in thickness from 6 to 18 inches. It presents the appearance of a highly rugose serrated mass, destitute of cleavage. Fracture irregular, denticulated, and rasp-like. Streak dull brown, indicating, as in the case of the Boghead, a cannel containing a large per centage of gaseous matter, with the same argillaceous base. Its specific gravity is 1·228. Weight of one cubic foot, 76·530 lbs. Under distillation it yields 13,600 cubic feet of 27¾-candle gas, and requires for purification from 100 to 105 lbs. of shell lime per ton.

SECOND ORDER.

Wigan Cannel.—In the second order of cannels those wrought at Scott Lane, Ince Hall, Rose Bridge, and Haigh Collieries, &c., Wigan, may be taken as the type. In this district they present a great uniformity in their lithological characters, and appear to have been deposited, with little variation in their composition, on the same geological horizon, the estuary or basin of which Wigan forms the axis, and where the seam is about 3 feet thick, thinning out in its diverging circumference from this point until it either crops out or terminates in shale. The beds are now greatly broken up, and their levels altered by the subsequent elevation of the hills, and the numerous faults and dislocations which intersect the district. The cannel is compact; colour, bright shining black; cleavage, cubical and conchoidal; fracture, highly conchoidal, glistening, and pitch-like, indicating a cannel possessed of high coking properties; thin deposits of carbonate of lime and minute crystals of iron pyrites in its plains of intersection; streak, bright black; specific gravity, 1·268; weight of one cubic foot, 79·250 lbs. Under distillation it yields 11,000 cubic feet of 23·3-candle gas, and requires for its purification about 118 lbs. of shell lime per ton. It may probably be worthy of remark that the only Scottish cannel closely allied to this is that known under the name of Bo'ness, of which the Kennell Iron-Works Company are the proprietors. In quantity and quality of gas it is uniform, but its coke is considerably inferior, though distinguished as the best amongst the Scottish cannels.

Hindley Cannel.—In 1867 a pit was sunk by the Bask Hill and Hindley Field Coal Company, in which a cannel of a very superior quality was found. I have not had an opportunity of identifying its stratigraphical position, but I think it probable it will turn out to be an altered condition of that found with the Wigan *four-feet* coal to be afterwards described. Its average thickness is about eight inches, and it is imbedded in sigillaria, stigmaria, and calamites. Colour, black, inclining to brown; thin lamina of carbonate of lime and minute crystals of iron pyrites in natural planes; cleavage, slaty; fracture, irregular; streak, dull brown; specific gravity, 1·084; weight of one cubic foot, 67·369 lbs., being the lightest cannel known; and, taking its primary and secondary products into account, would appear to stand at the head of English cannels. Under distillation it yields 12,890 cubic feet of 23½-candle gas, and requires for purification about 112 lbs. of shell lime per ton.

Dukinfield Cannel.—I am indebted to my friend, Mr. Longworth, for a specimen of this cannel, and he has also favoured me with the results of his analysis. From a careful investigation I am led to the conclusion that it forms an integral part of the Wigan cannel, doubtless thrown down by one or more faults in the Dukinfield district. Its lithological character and mineral composition are so uniform in every respect as to render a description unnecessary. Its specific gravity is 1·260, and the weight of a cubic foot is 78·524 lbs. Under distillation it yields 10,875 cubic feet of 22¾-candle gas.

Ramsay's Cannel.—This cannel is wrought in the neighbourhood of Newcastle-on-Tyne, and appears to be also contemporaneous with the primary Wigan bed, presenting mineral and other characters so closely corresponding therewith as to lead to the probable inference of a great coal-field having extended from the borders of Cheshire to the north of England, and probably over Scotland, of uniform geological age, and subsequently divided by the intrusion of the great mountain chains of Yorkshire, Westmoreland, and Cumberland; and it is highly probable the same field extends itself under the red sandstone of Cheshire, and connects itself with the Staffordshire beds. These observations, however, are foreign to our purpose. This cannel contains small concretionary deposits of iron pyrites, and occasionally of clay-band ironstone. The following description is taken from Mr. Lewis Thompson's "Chemistry of Gas Lighting," viz.:—"Compact and massive, slightly tinged with oxide of iron. Black and shining. Principal fracture highly conchoidal and resinoid; cross fracture conchoidal and cubical. Thrown on the fire, it decrepitates and flies to pieces; inclined to fuse. Specific gravity, 1·290." The weight of a cubic foot is, therefore, 80·394 lbs. Under distillation it yields "9150 cubic feet of 27·2-candle gas."

THIRD CLASS.

Lawton Cannel.—Of this class the Lawton cannel, near Stoke-upon-Trent, may be taken as the type. It is black and cubical, passing into a strong indurated shale on the upper side; cleavage, slaty, showing fragments of vegetable matter converted into iron pyrites, scales and bones of fish interspersed throughout; fracture, cubical, oxide of iron adhering to its natural lines of parting; streak, black; average specific gravity, 1·317; weight of one cubic foot, 82·077 lbs. Under distillation it yields 8000 cubic feet of 22-candle gas, and requires for purification about 146 lbs. of shell lime per ton. The residue drawn from the retorts retains the structure of the cannel.

North Wales Inferior Cannel.—The sill in the neighbourhood of Mold from which the curly cannel is obtained is, as I have already observed, from 4 to 5 feet in thickness. The base is composed of large cubical masses of inferior black-band ironstone, interlaminated with brown bands of

cannel. Its thickness is from 18 to 24 inches; colour, a mixture of brown and black; cleavage slaty, with a rough, coarse grain; fracture, cubical and irregular. Deposits of iron pyrites, coprolites, scales, teeth, bones, and other fish remains. Average specific gravity, 2·635; weight of one cubic foot, 164·216 lbs. Under distillation it yields 10,780 cubic feet of 14-candle gas. Owing, however, to the excessive quantity of sulphuretted hydrogen and carbonic oxide generated, requiring for its purification about 3 cwt. of shell lime per ton, it is not suited for the purpose of gas manufacture, nor would I have assigned it a place amongst the cannels were it not to bring its value before the profession, for although containing a considerable portion of bituminous matter, its proper designation is that of a *ferruginous shale*. Immediately over this the curly cannel is deposited, and which is again overlayed by a distinct transitional division, but without parting, known by the name of *smooth cannel*, which has an average thickness of about 10 inches. In its stratification it becomes more earthy and impure from its base upwards, until its bituminous character disappears in a strong black argillaceous shale. To a casual observer the best portions of it might be mistaken for Wigan cannel, but the difference may be readily detected by its being less conchoidal, more earthy in its texture, the clayey odour it gives off when breathed upon, and by the coke retaining the structure of the cannel when carbonized. Its colour is black, and partially shining; cleavage, flat conchoidal; fracture, cubical and conchoidal, with a rather coarse earthy grain; base, argillaceous; streak, dull to shining black; average specific gravity, 1·288; weight of one cubic foot, 80·269 lbs. Under distillation it yields 10,800 cubic feet of 22½-candle gas, and requires for its purification about 120 lbs. of shell lime per ton.

Before leaving this somewhat remarkable sill, it may prove interesting to many members of the association to know that it presents us with two great *fish beds*, one immediately underlying and the other immediately overlying the central deposit of curly cannel. The apparent universality of these remains, as distributed over their respective platforms of death, must render this district a centre of abiding interest to the geologist and palæontologist.

Wigan Secondary.—In addition to the primary bed of cannel in this district, there is a secondary deposit, of inferior quality, associated with the Wigan *four-feet coal*, having a geographical horizon about 386 feet above the primary cannel of the *King coal*. Its thickness varies from 2 to 14 inches, and is wrought at Low Hall, Ince Hall, Fir Tree, and Edge Green Collieries, in the Wigan district; in the west, at Peasley Cross, near St. Helen's; in the east, at Worsley; and probably at other places. It appears to vary considerably both in its lithological character and mineral composition, which necessarily affects the quantity and quality of its products. Probably the best portions of this cannel in the central district have not yet been examined. Those brought under my observation are as follows, viz.:—

Fir Tree Cannel.—This band varies from 2 to 5 inches in thickness, and its structure throughout indicates an accumulation of swamp or jungle—vegetation, consisting chiefly of great reeds, grass, and calamites, imbedded in a matrix of carbonaceous matter. About the centre of the band are generally found an abundance of cycliferous scales, head bones, and other fish remains, probably belonging to the genus *Cælacanthus*. The sample at my disposal contained about one-third of coal in partings. Its colour is black; cleavage slaty, showing a coarse granular texture, with vegetable impressions; cross fracture, cubical and irregular, with thin bright lamina in the line of stratification; streak, black; specific gravity, 1·213; weight of 1 cubic foot, 75·595 lbs. Under distillation it yields 11,900 cubic feet of 15·75-candle gas.

Edge Green Cannel.—The band here is from 2 to 4 inches in thickness, and is not separated from the coal. It contains less earthy matter than the foregoing, and gives a black streak inclining to brown. Its specific gravity is 1·244; weight of 1 cubic foot, 77·527 lbs. Under distillation, in its mixed state as sent from the colliery, and containing nearly two-thirds of coal, it yields 10,540 cubic feet of 19·63-candle gas.

Worsley Cannel.—This cannel has an average thickness of about 8 inches. Its colour is bright black; cleavage, slaty and flatly conchoidal. About the centre of the band are frequently found considerable deposits of striated shells, resembling *sanguinolites* and *anthracoptera*, but in a state too fragmentary to be properly identified. The pretty little crustacean *Beyrichia arenata* is also abundant in some portions, but these characters do not appear to be quite constant, and I have not found the latter associated with this band in other districts. Streak, black and shining; specific gravity, 1·290; weight of 1 cubic foot, 80·394 lbs. Under distillation it yields 11·030 cubic feet of 19-candle gas. Lime required for purification not ascertained.

These include the list of cannels with which I am at present acquainted, and should any others come under my observation I may continue, with your permission, to give them a place in the records of the association.

Before leaving this subject, I will refer briefly to the erection of large and important works by the Coal and Iron Company, Wigan, for the purpose, amongst others, of utilizing the vast accumulation of cannel slack, under the management of Mr. John Young, F.R.S.S.A., formerly engineer for the Dalkeith Gas Company. The process is one of considerable importance, and is likely to prove of commercial advantage and utility in thus multiplying the agencies of gas-producing materials without the further output of cannel. I am not in a position, at the present time, to offer an affirmative opinion of its commercial value, and as it is probable the subject will be again brought before you in a more definite form, it will only be necessary here to trace, in a few words, the outline of the process. The slack is passed through a pair of rollers about 3-10ths in the clear, and conveyed into a washing apparatus, where it drops into a spout and is carried by a current of water to the end of a cistern having a sieve placed about ten inches under the surface of the water. The sieve is fixed, but the water receives an undulating motion from a piston of large area which makes about 140 strokes per minute, and which lifts and suspends the crushed material in the water at every stroke; the pyrites and lime, separated by the rollers, arrange themselves in the order of their specific gravities, and by the time they have passed through the area of the cistern they have been subjected to something like 200 undulations. The impurities are now at the bottom, and the cannel is carried with the water into a waggon, dried, and triturated in a pug-mill with about 6 per cent. of paraffin pitch, compressed, and turned out as the sample before the meeting.

I have only further to add that I subjoin to these notes their respective analyses in a tabulated form, arranged in the order of luminiferous matter yielded by them per ton by its equivalent in pounds of sperm—Lancashire caking coal being taken as unity. The examinations were made in each case on not less than two tons of cannel, and the normal conditions of our working were not departed from.

ANALYSIS OF ENGLISH CANNELS.

Arranged in the Order of Illuminating Matter yielded by them respectively. Lancashire Caking Coal as Unity.

	Specific Gravity of Cannel.	Weight of One Cubic Foot in lbs.	Purified Gas per Ton.	Condensation by Bromine per Cent.	Illuminating Power in Sperm Candles of 120 Grs.	Value of Gas in Grs. of Sperm per Cubic Foot.	Value of Cannel per Ton in lbs. of Sperm.	Luminiferous Matter per Ton. Caking Coal as unity.	Weight of Coke in lbs. per Ton. of Cannel.	Ash in Coke per Cent.	Authority.
Wigan and St. Helen's caking coal (average)....	...	...	9,168	...	...	390	511	1·	...	...	Paterson.
Coed Talon, North Wales (shale).....	2·635	164·216	10,780	...	14·07	377	519	1·016	Nil.	...	Do.
Lawton, Stoke-upon-Trent	1·317	82·077	8,000	8·65	22·	533	609	1·192	...	72·	Do.
Fir Tree, Wigan district	1·213	75·595	11,900	...	15·75	378	643	1·258	1,210	13·7	Do.
Peasley Cross, St. Helen's	1·275	79·459	10,000	10·67	19·46	467	667	1·305	...	4·25	King.
Edge Green, Wigan district.....	1·244	77·527	10,540	10·20	19·63	470	708	1·385	1,348	7·83	Paterson.
Worsley	1·290	80·394	11,030	9·13	19·	456	719	1·407	1,439	7·32	Do.
Coed Talon, *smooth variety*	1·288	80·269	10,800	9·33	22·67	543	838	1·640	1,344	69·	Do.
Dunkirk, Dukinfield	1·260	78·524	10,875	...	22·75	546	848	1·659	1,568	3·	Longworth.
Ramsay's Newcastle	1·290	80·394	9,151	...	27·2	653	854	1·660	...	10·4	L.Thompson.
Wigan, Rose Bridge.....	1·268	79·250	11,125	11·75	22·63	543	863	1·690	1,414	5·	Paterson.
Wigan, Scot Lane.....	1·260	78·524	11,980	11·38	22·80	547	936	1·831	1,411	4·6	Do.
Hindley Field	1·084	67·369	12,890	13·75	23·25	558	1027	2·010	1,053	7·4	Do.
Coed Talon, *curly variety*.....	1·228	76·530	13,600	16·37	27·75	666	1294	2·532	903	68·7	Do.

The PRESIDENT said there was one portion of Mr. Paterson's paper with which he was particularly pleased, as it related to a matter he had never seen treated of before in such a communication—viz., the quantity of lime required for the purification of each description of coal. They all knew that it was a very important element in the consideration of the relative value of cannels, and he was glad to see that Mr. Paterson had gone into the question so elaborately. Of course, the paper was one more fitted for study than for discussion, and there was no doubt that when the transactions of the association were printed it would be studied by the members with advantage.

Mr. E. GODDARD (vice-president) read the following paper:—

ON THE CARBONACEOUS DEPOSIT IN RETORTS, THE MODES ADOPTED FOR ITS REMOVAL, AND THE USES TO WHICH IT MAY BE APPLIED.

The subject of this paper is so familiar to all gas engineers that it may appear almost superfluous to bring the subject under the consideration of a meeting like the present; but as one or two novel means for removing the incrustation from retorts have recently been patented, it occurred to me that a short time might be profitably employed in deliberating upon one of the prevailing difficulties of the retort-house, at least in the majority of gas-works, although I know that there are some gentlemen present who have succeeded in preventing the accumulation by the means they adopt for removing all pressure from the interior of the retort. That the deposition of carbon does arise from the pressure on the gas was, I think, clearly demonstrated some years since by the series of experiments carried on by Mr. Grafton, at the Cambridge Gas-Works, previous to which it was generally considered by most scientific authorities that the carbon was due to high degrees of heat and too great an extent of heating surface. Mr. Grafton conducted his experiments in such a way as to show very practically the truth of the conclusion he had arrived at. By increasing the pressure till it became equal to a column of 14 inches of water, he produced in a single week a layer one inch in thickness, and at the expiration of two months it had filled up nearly one-fourth of the retort. During this experiment an accumulation weighing 10 cwt. 20 lbs. was produced by the carbonization of 67 tons of Wallsend coals. Another trial, under entirely opposite conditions, was then made, all pressure being taken off except half an inch dip into the fluid in the hydraulic main. Under these circumstances, when the retort was again worked with the same description of coal for four months, scarcely any deposit had taken place.

What, then, is this carbonaceous deposit? It is generally considered

that the carbon is derived from the decomposition of the gas, the volume of gas becoming expanded by the heat from the retort, whilst a portion of its carbon was deposited upon the retort. And this theory appears to be borne out by the fact that if olefiant gas is passed through a red-hot tube, a portion of the carbon will be deposited in the tube in a solid form; whilst, on the contrary, other scientific men were of opinion that the derivation of the carbon was from a portion of the tar. The vapour of the tar generated from the coal consisted of a number of compounds; that was to say, it was not homogeneous, but heterogeneous. The coal did not contain a single compound ingredient that it produced—neither gas nor tar, nor any of the other compounds derived from it; but when undergoing destructive distillation, part of its several elements reunited, and formed various volatile compounds which passed off with the gas. A portion of the carbon, however, contained in the tar, having nothing to combine with, became deposited in the retorts.

Whichever theory was the correct one, certain it is that the carbon is deposited, and numerous appliances have been resorted to in order to remove it, amongst which may be mentioned a spray of water, a jet of steam, cold air blast, and tubes through lids; and, at the meeting of the association held at Birmingham, 1865, Mr. Methven read an interesting paper, detailing the plan adopted by him of open-ended retorts, which in its action very nearly approximated to the plan patented by Mr. Hislop, which I will presently describe. Most of the plans I have referred to are slow in process, and destructive to the retort, from the amount of chiseling required to dislodge the carbon; but in the plan recently patented by Mr. James Hislop, a member of this association, and the engineer to the Ayr Gas Company, all other plans (in his opinion) have been superseded, inasmuch as the carbon can be removed without the use of the chisel-bar, and without injury to the retort. In his plan, he has placed a pipe under the floor parallel to the retort-bench, one or both ends of which are connected with the main flue of the chimney-shaft. Along this line of pipes, and opposite to each retort, is a socket cast for the purpose of receiving an upright pipe, to the top of which is fixed a horizontal pipe, sufficiently long to reach within a foot of the back end of the retort (as shown in the diagram). The lid of the retort having been removed, the horizontal pipe is inserted, and connected with the pipes below the floor. The consequence is that a strong current of air, induced by the draught in the chimney, rushes into the mouth of the retort, and traversing on toward the open end of the horizontal pipe, and thus bringing the oxygen of the atmosphere in contact with the incrustation, causes the carbon to fly off in particles with a rapidity truly astonishing. By these means the carbon may be removed with the greatest facility without endangering the retort, or having recourse to chisel-bars. I have received a communication from the engineer of the Paisley Gas-Works, where Mr. Hislop's patent is in use, and he speaks of the plan in the highest terms of commendation.

The same object—viz., that of producing a rapid current of air in the retort—is effected by a very simple means, invented by Mr. G. W. Edge, engineer of Jersey City Gas-Works, New Jersey. His apparatus consists of a steam-pipe connected with the steam-boiler, and passing along the top of the retort-benches, to which is connected a 1-inch pipe, extending out to the face of the retort mouthpiece; to this is connected a half-inch pipe, having on it a stop-cock and union joint to connect and disconnect the pipe readily. This steam-pipe terminates at the end of a pipe 3 inches in diameter, and about 5 feet long, resting on the bottom of the retort, into which the steam rushes through a nozzle having a 3-16th-inch outlet, at the same time drawing with it a current of atmospheric air. A retort-lid is cut out to fit closely around the 3-inch pipe. The lid is luted on tight, and the plug removed from the top of the ascension-pipe, the retort being at a good working heat, and the apparatus is ready to perform.

The steam should be used at a pressure of from 25 to 40 lbs. to the square inch. The rush of steam carries with it a current of atmospheric air, the cast-iron pipe becomes heated, and the steam and air rushing through it become superheated, and thus we have a compound blow-pipe of immense power, the current of which strikes with great energy on the thick portion of the carbon at the rear end of the retort, but with diminished force as the returning current partially charged with the products of combustion approaches the front end of the retort, where the carbon is thin, in order to pass out through the ascension-pipe. If the retorts are thickly coated with carbon (say several inches thick), on the first application of the apparatus it will require several hours to clean them out; but when the retort is once decarbonized, one hour's application every thirty days will be found amply sufficient to keep the retort clear of extraneous carbon. This is a great *desideratum*, for in this way the composition of the retorts is changed (by the carbon which permeates them), thus acquiring a metallic character and hardness, their strength and durability is increased, they are not affected by the highest temperature, and are rendered almost indestructible.

Another plan for scurfing retorts to which I will refer is the one for which letters patent have been secured by another member of this association, Mr. John Somerville, of the Maidstone Gas-Works, whom I very much urged to give a paper at this meeting upon his invention, the object of which is "to remove with rapidity the deposit of carbon which accumulates in and adheres to the retort used in the distillation of coals for the manufacture of gas." The improvement consists in scurfing by the following means:—A pipe is introduced in the retort of sufficient length to reach within a few inches of the back end; the retort is then charged with a quantity of chalk, limestone, or refuse lime from the purifiers. A retort-lid is provided having a hole through which the pipe just referred to is drawn, leaving a few inches projecting on the exterior. The lid is luted, and secured to the mouthpiece in the usual way. The cap on the top of the ascension-pipe is then removed, and a current of air established through the pipe and amongst the chalk or limestone in the retort. By this means the chalk or limestone, in the course of a few hours, will be converted into quick lime, and the carbon adhering to the retort removed. Thus not only is the retort freed from a deposit which is in every respect prejudicial, but an excellent lime is produced without (as the patentee assures me) injury to the retort, and which may be used for the purification of gas or other purposes. When the retort is charged with spent or foul gas lime from the purifiers, it becomes revivified, and may be used repeatedly. The action I understand to be this: the carbonic acid gas, being evolved from the chalk, takes up another equivalent of carbon from the retort, and escapes as carbonic oxide. In the case of foul gas lime being employed the sulphur is evolved, and, combining with the carbon, may be received into an apparatus connected with the ascension-pipe, and conveyed to a condenser, and there deposited as bisulphide of carbon, which possesses the greatest solvent power for india-rubber, and is largely employed in the manufacture of waterproof clothing. It is also extensively used in the manufacture of vegetable oils. Bisulphide of carbon having a strong affinity for grease, it is used for extracting the portion of oil that remains after the seeds have been subjected to hydraulic pressure, and as it distils at a low temperature it can very readily be re-collected and used time after time.

The carbonaceous deposit in retorts, being almost pure carbon, is valuable in the manufacture of steel. It is used with plumbago in the manufacture of crucibles and melting-pots; it is employed in the construction of the galvanic battery, and is the best material that has yet been discovered for the points of the electric light. It is used for adulterating black lead, and is known in the market as the housemaid's friend; and also in the manufacture of gunpowder for blasting purposes it forms an important ingredient.

Mr. G. Anderson said it appeared to him that there was one serious objection to Mr. Hislop's plan—viz., that the air entered the mouthpiece and came back through the small tube and thence to the chimney. The consequence was that the front of the retort, where, as was well known, the carbon did not accumulate, first received the advantage of the system, and the retort must necessarily become very cold and liable to crack by the admission of so much cold air. He thought in this respect the plan adopted by Mr. Somerville was better, because the air passed through the tube and did not touch the retort until it reached the spot where it was most required. Another advantage in it was, that it protected that part of the retort on which there was no carbon. If the retort could be thoroughly filled up with coal and coke in the process of working, no carbon could be formed; it was on that part where the coal did not lie that the carbon accumulated, and by Mr. Somerville's plan he filled that portion with limestone, so that in the operation of scurfing the other parts this was protected from the atmospheric air—a most important consideration. He did not know whether the carbonic acid took up an atom of carbon and became carbonic oxide in this process, but that of course could be proved by lighting the top of the pipe. Mr. Somerville, as he understood, proposed in place of chalk or limestone, to use for the purpose the refuse lime from the purifiers; but this was a plan which could not be satisfactorily adopted in districts where the people were at all inclined to be quarrelsome, unless special care was taken to prevent the fumes from getting into the atmosphere.

Mr. Somerville said the difficulty attending the scurfing of retorts by the old plan was well known to all gas managers. By his process the bottom of the retort was profitably employed during the operation, and without the aid of chisels and bars, which were so destructive, the retort was in a few hours restored to as clean a condition as when first put up. At the last meeting, at Nottingham, the president (Mr. Hawksley) brought before the members the importance of considering whether anything could be practically done with the foul lime of gas-works, and acting on the suggestion, he (Mr. Somerville) determined, on returning home, to try the experiment. He found that by using it in this way he not only succeeded in scurfing the retorts with facility, but that the lime itself was revivified and could be used again repeatedly. He had some by him now that had purified gas seven times, although after the first few revivifications it did not come round quite so rapidly. He had fancied that by the decomposition of the combined carbon of the retort and the sulphur from the waste lime, he ought to obtain bisulphide of carbon, but in this he had not succeeded, the fault being, as he believed, more in his condenser than anything else. It was there he had no doubt; the difficulty was how to get it out. If it could be done profitably, the thing might be easily managed, because a pipe could be taken from each ascension-pipe to the condenser. That by this process the lime was revivified and made fit for purifying gas again was a fact, but even if not used in the purifiers it made an excellent concrete for cementing purposes. In this way this plan of scurfing retorts offered the additional recommendation, that it enabled gas managers to get rid of their foul lime, which was generally a great nuisance.

Mr. Methven asked whether the cast-iron pipe employed was liable to collapse. He had tried the plan, but without using chalk, and he generally found it a slow process, and that the carbon was burned out of the cracks of the retorts. With the assistance of chisels a man could scurf a retort in six hours, but by this plan it would, as it seemed to him, require sixteen hours, which was a serious drawback.

Mr. Somerville said the cast-iron pipe in the first instance did collapse. He overcame that difficulty by using a piece of fire-clay pipe 2 feet long at the least end of it, and then both came out whole.

Mr. Copland said the mere introduction of a pipe at the back of the retort would in most cases remove the carbon most effectually, and it was a plan which worked successfully with no expense. In all large works the adoption of through retorts was the most satisfactory arrangement, but in small works, where other means for removing the carbon were necessary, the plan proposed by Mr. Cockey, of Frome, seemed effectually to meet the difficulty; it was, in fact, the adoption of through retorts on a small scale, and by its means retorts could be cleaned out in five or six hours.

Mr. Cathels agreed with the last speaker that the most simple and effectual mode of getting rid of the carbon was to make through retorts of short retorts. In most works this could be done at a small cost. If the retort-house was in the yard, an arch corresponding to the arch of the oven could easily be made, and a short mouthpiece 6 inches in length was all that was required. By this means there was not only the advantage of taking the lid off and getting a current of air through, but the further advantage of getting to the back of the retorts to repair them. In country gas-works, where there were no open ends, it was sometimes a difficult matter to get at the back of the retorts; but by this method the setting of the retorts as well as their repair was facilitated. He had himself altered some short-ended retorts in that way; the cost was very little indeed, and the working results were extremely satisfactory.

Mr. Copland said the plan Mr. Cathels suggested had been in use in Norwich for some years. In this case he adopted a short mouthpiece instead of a pipe. Mr. Tadman, the manager of those works, was present, and could, perhaps, better state the result.

Mr. Tadman said the plan had not answered, because they had been obliged to build a wall up at the back of the retorts.

Mr. Douglas thought Mr. Copland's remarks ought not to be lost sight of. In all small gas-works it was difficult to get rid of the pressure and the carbon. The pressure in the retort was often much reduced by seeing that the ascension-pipe was of a proper size. If it were not so the pressure would cause the deposit of carbon. The only hope he had of getting rid of the difficulty was by getting rid of the dip.

Mr. Esson thought that Mr. Douglas had thrown out a suggestion which was well worthy of consideration. It was known to many of the members that for some years he had had retorts in action without any seal. He should certainly never think of introducing a seal between the exhauster and the vessel in which the coals were carbonized. In this way he could go on from the time he lighted up in autumn until he let down the furnaces in the spring, without any of those ingenious processes for removing carbon which had been referred to. There was a method adopted by Mr. Young

in Scotland, some years ago, which nearly approached the method just described, and which gave considerable satisfaction where it was adopted. In that case the retort was set singly, and the posterior end was contracted, in a conical form, to half the diameter of the retort. It had a mouthpiece at that end, fitted with a cover. The lid of the front mouthpiece was cast with an arc in the upper part, which left an opening into the retort, by which a current of air was established towards the other end. The lid on the back end enabled him also to get a current in either direction. The objection to the use of a tar-seal was, that the tar became converted into pitch, and it required to be taken down and cleaned out. To avoid this troublesome process he had had recourse to a throttle-valve, and the rod by which that valve was opened and shut was hooked upon the lid, so that it was impossible to remove the latter without shutting the former. When the pressure was taken altogether from the retort or oven there was very little trouble in stopping the escape of gas by the mouthpiece. Although it seemed rather a dangerous proceeding, he might state that he had had it in use for twelve or fourteen years, and never met with the slightest accident. Only on rare occasions had he had to burn out the carbon, or resort to any other process of getting quit of it during the winter's operations.

Mr. CATHELS asked Mr. Esson how, with the use of a valve only, the escape of gas was prevented for the time being. After the retort was charged, at what part of the operation was the throttle-valve opened?

Mr. ESSON said the lid could not be removed till the throttle-valve was shut, and, if put on without the valve being opened, the retort was not so tight but that it would give a very prompt indication of the fact.

Mr. YOUNG said an improved mode of decomposing the carbon of retorts was suggested to him by the difficulties experienced during many years connexion with gas-works and the working of single-ended retorts. At first he had a retort-cover cast for the back of the retort, with a hole 6 inches in diameter, and a pipe through which he allowed the air to pass to the anterior part. He found, however, that the pipe, though heated to that temperature, collapsed; or, if it did not, it had such a power over the air as partially to decompose it, and render it useless for the removal of the carbon. It ultimately occurred to him to place a cone on the back part of the retort, tapering to a 6-inch hole in the centre, and fitted with a cover. The cover for the front mouthpiece was cut off in section, and by placing that part towards the top, and removing the small cover from the cone behind, he established a current of air from the rear to the front. The oxygen passing into the retort in this way immediately attacked the carbon at the rear end, which in a few hours was so thoroughly loosened that a slight action of the bar removed it. The door in the front was then turned upside down, and the current reversed; so that the anterior part of the retort was cleared of carbon in the same manner.

Mr. J. CHURCH said the plan he adopted a few years ago was to insert an earthenware pipe at the bottom, with a temporary pipe of thin sheet iron, like a stove-pipe, let into the flue. He found that in this way he established a current of air so strong that it required to be regulated; in fact, it operated as a blow-pipe. He found, by regulating the current along the top of the retort, it formed channels in the carbon, which could then easily be removed by bars, and the retort completely scurfed in five or six hours. The great danger was in the breaking up of the solid mass of the carbon.

Mr. G. LIVESEY said it occurred to him that the object they should chiefly aim at was the prevention of deposit rather than its removal afterwards. Mr. Goddard, in the earlier part of his paper, spoke of pressure as the cause of deposit, and Mr. Douglas suggested that the ascension-pipe ought to be made larger. But there was one cause of pressure not yet mentioned, and that was when an ordinary dip-pipe was used a very pitchy substance, and often a crystallizing deposit, was found in the hydraulic main. The plan he had adopted to get rid of that was to have a 2-inch pipe connected with the blow-pipe and steam-boiler, and periodically this was turned into the hydraulic main; a rush of water flowed through the main, and did a great deal to keep it clear. As to deposits in the retort, he could not, from his own experience, say much; but he might remind the members that the smoother the surface of the retort the less likely were they to have difficulty in this direction. It might not be generally known that at Ewell, in Surrey, a sandy clay was found which was used in London in the setting of retorts, as it was very refractory. He had had a number of ovens set with bricks made from this clay, and in these retorts there was no incrustation whatever. With Stourbridge and Newcastle bricks he found there was a little deposit, but these were no trouble, and he never had his retorts open more than an hour or an hour and a half.

Mr. MILES said for some years he had been in the habit of using a sharp steel rake for the purpose of removing carbon from the top of the retort after every fourth charge or so. He found that when the stokers did their duty, this prevented in great measure the deposit. Unfortunately there was the difficulty of keeping the men up to the mark in this respect. He should like to ask how long a retort would last by the adoption of the plan which had been referred to. He could not make his last more than two years, but he had heard of some managers who could make them last four years.

Mr. PATERSON thought that of all the suggestions put forward, the one for which they were indebted to Mr. Esson was, perhaps, the most worthy of attention. Their great object was certainly to get rid of pressure, and he thought it was a question whether, even in small works, it would not pay to erect an engine and exhauster for the purpose. All the plans for the removal of carbon were more or less desirable, but he confessed to a preference for the one proposed by Mr. Young. With respect to the duration of retorts there was a great difference of opinion, but after a considerable experience in the working of clay retorts, he had come to the conclusion that it was not judicious to continue their use for too long a period. After eighteen or twenty months active working, they became so thoroughly vitrified that it was much better to pull them out than to keep them in operation.

Mr. FRASER said all the processes put forward for the removal of carbon from retorts had, more or less, that which was objectionable in them. The question really seemed to him to be so to arrange the apparatus that the pressure should be reduced to the minimum. By enlarging the ascension-pipe, and having the rest of the apparatus throughout the works of sufficient dimensions, and keeping them free from all obstruction, they would to a considerable extent attain this end. It was a great objection in small works to place short retorts against a blank wall where there was no chance of getting behind them. He had adopted the plan mentioned by Mr. Copland for eight or nine years, and found very little difficulty in the matter. After all, the *desideratum* was not so much the removal of carbon as the prevention of its formation. By the deposit of carbon there was the loss of illuminating power in the gas to a considerable extent, obliging them to use cannel to supply that which was worse than wasted, because it caused much trouble to get rid of.

Mr. GODDARD said, in preparing the paper which he had read, he was influenced by the desire to bring before the association a subject which should have a practical bearing. He was very glad that he had selected this subject, because it had elicited some observations which he thought might be useful to the members generally. Unquestionably, the best plan to adopt was to remove all pressure from the retorts, but there were difficulties about that which, being dependent upon the working men of the establishment, might sometimes be of considerable magnitude. The remarks made by Mr. Livesey respecting the Ewell bricks were, he thought, worthy of consideration. The silicious matter forming those bricks vitrified at a low temperature, and formed a glaze which made them particularly well adapted for retorts and furnaces. But where Newcastle or Stourbridge clay was employed, it was necessary to form a certain amount of carbon in the retorts so as to make them tight vessels, or there was a loss of a large amount of gas through the porosity of the material. The difficulties which had occurred to his mind in connexion with the plans he had brought forward, he would just make a remark upon. With regard to Mr. Hislop's plan, the heat produced by the rapid draught was so great as to destroy the pipe, which very soon collapsed. It certainly removed the carbon, but the destruction of the pipes was a serious consideration. In the plan adopted by Mr. Somerville, he was not quite sure whether the effect of the lime upon the clay retorts would not be to form a flux, and thereby deteriorate the retort to a certain extent. He believed the quickest way to remove carbon, where it existed, was the plan adopted in America. A jet of steam was introduced at the edge of the pipe, which produced a very rapid draught. The air became superheated, the flow of steam kept the pipe from collapsing, and the rapidity with which the carbon was removed was much greater than by any other method he had seen adopted. During the past week he had tried it by way of experiment on some retorts where there was a large deposit of carbon, and it certainly was most effectual in an incredibly short space of time.

The PRESIDENT asked what the value of the carbon was in the market.

Mr. GODDARD said he believed the carbon readily sold for steel-making at 15s. per ton. The founders in his neighbourhood would take it in almost any quantity, and there was a good sale for it among the manufacturers of plumbago pots. It was used extensively for crucibles, and there was no difficulty in getting a ready market for it. The only real difficulty was to keep down the supply.

The PRESIDENT remarked that the discussion which had followed the reading of the paper left him very little to say. He might, however, remark that he thought Mr. Esson had hit the right nail on the head when he said that the remedy for all the inconvenience was to go at once to the source of the evil. And as it had been proved over and over again by careful experiment that distillation under pressure was the means of increasing the quantity of carbon, their attention should be more directed to the mechanical appliances by which that pressure could be removed. He recollected seeing the apparatus that Mr. Esson alluded to when the works at Cheltenham were in the hands of Mr. Spinney. The hydraulic cup in use at that time he presumed was in use now.

Mr. ESSON said he now used a throttle-valve.

The PRESIDENT said the little apparatus he referred to in his opening address, of Mr. Cockey's, by means of which the dip-pipe was raised out of the water, presented, perhaps, one effectual means of overcoming the difficulty. Of the different modes of scurfing retorts by means of atmospheric air some were very ingenious. The first one he recollected was employed about thirty years ago by Mr. Kirkham, sen., at the Imperial Gas-Works. It had a blowing action to set the air in motion, and, the cap being taken off the rising main, the carbon was very soon driven out. All the plans which had been adopted since, with the exception of the steam-jet and Mr. Somerville's chalk or lime process, were modifications of that one, and they all seemed to possess their special merit. The result of experience might enable the members during the coming year to decide which, upon the whole, was the best. Mr. Copland's suggestion was not, he thought, a very modern one. He recollected that when Mr. Copland began the manufacture of clay retorts he made them with an aperture at the end, so that access could always be had to them. Of course that plan could not be adopted where retorts were set back to back, but by means of open-ended retorts it could always be practised with advantage. The association were much indebted to Mr. Goddard for the paper read, and which had led to so interesting a discussion.

Mr. JAMES SHARPE, of Southampton, introduced the subject of

THE DEPOSIT OF NAPHTHALINE IN SERVICE-PIPES AND MAINS.

Mr. President and Gentlemen,—No one that ever stood forward to address the members of this association needed your sympathy more than myself on this occasion, because I am about to bring before you a difficulty with which gas managers have to contend, without having the means of recommending a remedy. I need not say to you that the collection of naphthaline in service-pipes and mains is a question of the greatest importance, for I suppose there are no gas-works in the kingdom which are not troubled with it, except some few in the midland counties, where a different kind of coal is used. I said to my successor in the works from which I have just retired, "Naphthaline—what will you do with that?" He said, "You are going to London, and will there meet with some clever men; try and learn from them what ought to be done." The thought struck me that instead of going to inquire individually of the members, I would bring the subject boldly before the association, without any apology for so doing, and ask you, gentlemen, to suggest a remedy, for which I assure you I shall be obliged. It will not, it is true, benefit me personally to know, for I have retired from active life, being within two years of eighty years of age; but if, by introducing the subject, I can elicit some information which will be useful to my younger brethren, my object will be accomplished. I have been told that passing the gas over a large surface of tar will prevent it. I have only heard of this recently, or else before I was out of practice I should have tried it. In a district where I was very much troubled with it I had the syphons filled with crude naphtha, and in some instances I found that was efficient, especially when they were near the premises where the service-pipes were frequently choked. But if they were far from the premises it had no effect whatever. I conclude, therefore, it was because there was so small a surface of naphtha exposed to the gas. I have a very strong opinion of the correctness of what has been told me, that by exposing the gas to a large surface of tar there would be great benefit derived. The works with which I have recently been connected will, in the course of next winter, be second to none in excellence of arrangement; but still this naphthaline is a subject of great perplexity to them, and I do assure you that if some remedy can be suggested by the members of this association I shall be greatly delighted. With respect to the collection of naphthaline in the inlet of the gasholder, I always removed that by having a portable steam-boiler drawn up close to the inlet, and sending high-pressure steam through it. It did not melt the naphtha-

line, because the steam got so reduced in pressure; but it divided it, and then, by pouring in a large quantity of hot water, we so loosened it that it was easily removed; but I want something to prevent its accumulating. Now, in Southampton, in one building—a large hotel—they cook by gas, and use a great deal of it, and I have always found that when there was a slackish draught and demand on the main during the daytime, the naphthaline accumulated much sooner than where such is not the case. In one instance, where there was a large service-pipe passing for some 10 or 15 yards across a cold area, which kept it at a very low temperature, they were continually troubled with a stoppage from this cause, and I was frequently having complaints that they could not get gas for use when cooking the dinner. To remedy the evil I bound the service round with two or three thicknesses of list, and I was never troubled with naphthaline on those premises again. Now, we know very well that high heats conduce to its formation, and clay retorts are said to do so; but till very recently I used iron retorts exclusively, and yet I was exceedingly troubled with it; although I need not tell you we can use iron retorts at the same heat as clay. Some years ago I inquired of Mr. Lowe if he could suggest a remedy. "I wish I could," he said; "I should be a clever fellow. We supply Buckingham Palace through two 4-inch service-pipes; one of those is continually becoming choked with naphthaline, while the other remains free. I cannot tell how it is; it is so arbitrary in its formation." Now, I have heard of very large works in the midland counties, where they use the same kind of coal that others do who are so troubled with naphthaline, and yet they never have any. I think the reason is that they work at very low heats; but I need not tell you, as practical men, that if you work at too low a heat the production is very bad—you cannot get the quantity of gas out of the coal that you ought to get. I have no doubt there are gentlemen present who have had experience in reference to the deposit of naphthaline in service-pipes and mains, and who may be able to offer some suggestions for remedying the evil, which will be of practical benefit to their brother members.

Mr. CATHELS said two years ago he was very much troubled with naphthaline, and found it necessary to plunge the inlets of the gasholders once a fortnight or three weeks, and the inlets and outlets of the station-meter were never thoroughly clear. A large number of the services in the district also required to be blown out continually. During the last summer his company constructed a condenser on the battery principle, and the difficulty which always presented itself to him in connexion with condensers of that description was the liability of the horizontal pipes to get choked up with tar to such an extent that, unless during the cold months they were frequently steamed, the gas was prevented from passing. A gentleman residing at Croydon recently called upon him and suggested a plan for getting rid of the naphthaline. He did not know that there was anything new in the plan, for Dr. Letheby told them the same thing two years ago; it was simply to keep the gas in combination with the tar and ammoniacal liquor as long as possible—in fact, to condense the gas in combination with the tar and ammoniacal liquor. Both having a strong affinity for the naphthaline, as it left the gas it was deposited in the tar-wells. Not being exactly in a position to do that, instead of steaming the condenser last winter, he allowed the tar to accumulate round the horizontal pipes, and the result was that though manufacturing gas under the same circumstances, with the same quality of coals, and the same heats as the winter before last, he had been entirely free from naphthaline. He was not under the necessity to plunge the gasholders once, and had no trouble either inside or outside the works, except now and then in the service-pipes, but even there not to one-hundredth part the same extent. Judging, therefore, from his own experience, he had no hesitation in saying that this was a very feasible way of getting over the difficulty. In the outlets of his condensers there was an accumulation of a thick substance, something like cream, and, to satisfy himself that the condenser was really doing its work, he sent some of this stuff to Dr. Letheby, who assured him that it consisted of naphthaline held together by the tar.

Mr. SHARPE said the gentleman referred to by the last speaker was Mr. Thompson, of Clifton Road, Peckham, from whom his successor at the Southampton works had had a communication on the subject of getting rid of the naphthaline.

Mr. PATERSON said he had not till recently felt the importance of this matter, not having had much experience of the difficulty referred to. But during the last few weeks there had been a considerable decrease of pressure on the mains of one of the districts supplied by this company, at some distance from Warrington. On examining into the cause, it was found that there was a considerable deposit of naphthaline in a pipe about a mile from the town, which deposit had taken place through a quantity of spun-yarn having been left in one of the joints of a 4-inch main, causing a great reduction in the pressure. He was not at all troubled with it on the works, but during last winter some of the public lamps were stopped up with it. This was got rid of by putting a drop of naphtha on the top of the burner, which caused it to dissolve. He was quite ignorant of the causes which led to the formation of naphthaline, but thought it was probably, as Mr. Sharp suggested, from the employment of too high heats. In his works he used 30 per cent. of cannel, but even that had not sufficient solvent power to prevent the formation of naphthaline.

Mr. SHARP, in reply to an inquiry, said it was only recently that cannel had been used in the Southampton works. That had been on account of the fixing of clay retorts. He was in connexion with those works for 20 years, and never used cannel. He employed iron retorts, and when these were new he got 9300 cubic feet of gas per ton of coal. The heat required for iron retorts was not nearly so high as for clay. He believed that low heats would tend to diminish the liability to the subsequent formation of naphthaline, but then the quantity of gas could not be obtained.

Mr. G. LIVESEY said when his father first went to the South Metropolitan Gas Company the Mr. Thompson who had been referred to was the foreman of the works, and therefore he was a man of some experience. He had for many years advocated the system of allowing the tar to flow with the gas as far as possible—in fact, till the gas was thoroughly condensed. In his (Mr. Livesey's) works they had always used horizontal condensers, and for many years they were not troubled with naphthaline to an inconvenient extent; recently, however, they had had more than was desirable, and he attributed this to the fact that with a larger make of gas they had the same pipes, so that it had to flow much quicker from the hydraulic main through the condenser than it formerly did, and there was not sufficient time for the removal of impurities. He was now putting up additional mains in the retort-house, so as to make the gas travel about double the distance it had hitherto done. In this way he hoped they would be restored to the state they were formerly in. It did not do to condense too rapidly. He was once told that gas could not be condensed too much. He tried an experiment in that direction, and found in less than a fortnight that the mains about the purifier were completely filled with naphthaline, the fact being that the tar and liquor were entirely removed from the gas in the first two or three lengths of pipe, and had not been kept in contact sufficiently long to deposit this troublesome substance. Since then he had adopted the plan of condensing as slowly as possible, and of allowing the tar and liquor to flow along with it as far as practicable. He believed that Mr. Thompson was among the first to state that this was the right way to get rid of naphthaline.

Mr. YOUNG said he had just the same experience at the Stoke works that Mr. Livesey had spoken of; and, on making such an alteration as suggested, and separating nothing till the gas reached the first leg of the condenser, he now never found a particle of naphthaline in any direction. His make was from 230,000 to 250,000 in the winter time.

Mr. ANNAN said some years ago he was much troubled with naphthaline in a 14-inch inlet to a gasholder, but, on adopting the plan suggested, he had never been troubled with it since.

Mr. GARNETT said that if the apparatus for manufacturing gas was sufficiently capacious, and the gas was allowed to pass slowly with the tar and ammoniacal liquor, and was afterwards well scrubbed with the liquor, there was little or no danger of deposit of naphthaline. For getting rid of it in the inlet of a gasholder, provided it was on the outside of the tank, he suggested that the flange on the top should be removed, two sheet-iron discs somewhat smaller than the barrel of the pipe cut out, an inch pipe screwed into the back, so as to make a piston, and then five or six of the men set on to pump it out, which could be done in half an hour. He believed that the use of steam and hot water was thorough rubbish.

Mr. FRASER said he had used iron retorts with low heats, and had never been troubled with naphthaline.

Mr. METHVEN worked with clay retorts at high heats; his condensers were vertical, and he knew nothing about naphthaline on the works, though he had met with it in the streets on cold nights. He used Pelaw Main coal, and no cannel.

Mr. G. ANDERSON said he had had some experience of naphthaline, and from a series of observations he believed that the causes of it were perhaps two or three-fold. One of those causes was purely mechanical. He knew instances where naphthaline was found in the inlet of one gasholder, and not in any of the others; in the inlet of one station-meter, and not in that of the other, with the same gas going through both sets of pipes. In those cases the cause must be purely mechanical. In one gasholder where he was troubled with it, he found on plunging the pipe and then looking down it that naphthaline had begun to form exactly at the level of the water outside the pipe, where it formed a complete ring at a distance of perhaps 10 feet down. He had had services with naphthaline in them at one time, but when carefully lifted to examine the condition under which it was formed, it was only found at one of the collars where the thread had been roughed into the pipe and caused a projecting surface. With regard to condensing slowly, he quite agreed in the observations which had been made, as also in the remarks about the propriety of allowing the gas to flow in combination with the tar and ammoniacal liquor as far as possible, and washing with the liquor. With reference to steaming the mains being useless, he remarked that on one occasion he had a main-pipe which gave him some trouble, and which was steamed with water almost every month. It occurred to him that this itself might be the cause of the deposit of so much naphthaline, as, on examining the pipe, he found it as clean as when it left the mould. He accordingly employed the vapour of naphtha, using for the purpose the little tank of one of Walker's portable boilers. The vapour entered the pipe very rapidly, and was pumped out and used over and over again. He had not had to steam that main since. With mains having a highly smooth surface, well constructed works, provision against sudden transition of temperature, easy bends, a constant nice flow of gas, not too rapid, and with gas of 14-candle illuminating power, there was not much fear of the deposit of naphthaline.

The PRESIDENT said his experience, to a considerable extent, confirmed the theories advanced on both sides. No doubt, as with regard to the deposit of carbon in retorts, in this case, too, prevention was better than cure, and it would be wiser to direct attention to prevent the formation of naphthaline than to contrive means for getting rid of it after it was formed. Mr. Sharp spoke of a case in which a little crude naphtha had been employed at the burners. If, instead of crude naphtha, highly rectified naphtha, which would vaporize at 75° or 80° of temperature, had been placed in the syphon, in the current of the gas before coming to the spot where the obstruction took place, it would have been more efficacious. In many cases in which he had been concerned, he had observed the beneficial effect of allowing the gas to remain as long as possible in combination with the tar and ammoniacal liquor, and causing it to flow as slowly as possible.

Mr. G. ANDERSON read the following paper:—

ON THE CONSTRUCTION OF GASHOLDERS.

Gas engineers are not agreed upon the leading principles that ought to govern them in the construction of gasholders. One engineer objects to telescopic gasholders; another objects to put in an internal trussed framing under the roof sheeting; another objects to do without such a framing; another guides the gasholder by the application of cylindrical columns; another by flat tripods; another by flat openwork standards; and gasholders under all those different modes of construction may be said to act equally well. However, when such differences exist, there must be a better and a worse mode; and it is a fact that gasholders are occasionally built that do not work satisfactorily, but are the cause of great annoyance, and sometimes of considerable loss.

The highest morality has been defined as that which produces the greatest good to the greatest number, with the least evil to the smallest number. So, in engineering, that may be defined as the best and most worthy mode of construction which produces the greatest amount of value for a given amount of money with the least consequent defect. I shall, therefore, proceed to state my views of the mode of construction which I consider best calculated to arrive at that result.

When I undertook to prepare this paper I was not aware that one on the same subject had been read before the society three years ago. I have, therefore, perused that paper, and the discussion on it, in order that I might break up new ground, rather than cross-plough my neighbour's land; but the perusal of the discussion which followed the reading of that paper has not altered my views, which always have been that trussing in the crowns of gasholders is not only not necessary, but is an expenditure that they would be much better without.

Why do engineers put rafters in the roofs of gasholders? Why, just because rafters are put in the roofs of houses.

> 'Tis custom forms us all.
> Our habits, manners, and most fixed beliefs,
> Are but the chance and accident of birth.

I remember, some twenty years ago, having the opportunity of entering a gasholder of one of the metropolitan companies when it was inflated with air; it had a very heavy trussing in the roof, and I determined to examine the same very carefully. The first circumstance that struck me was that the sheeting, although built on the trussing, did not lie on it when inflated, but gradually rose off it, beginning from nothing at the outer kerb, and reaching 6 inches off at the centre. This led me to a discussion with myself on the proposition whether it was the trussing supported the sheeting, or the sheeting the trussing. I concluded in favour of the latter.

About this time a gasholder was built at another metropolitan works without trussing, and it collapsed, which led me to inquire into the manner of its construction, and I found that, while the trussing had been abandoned, no extra strength had been given to the outer angle-iron at top, which clearly was an oversight.

The subject was of much interest to me at the time, for I was engaged in the preparation, under Mr. Croll, of the scheme which a year or two after appeared as the Great Central Gas Company of London. I had a conversation with Mr. Croll on the subject, and found his mind was thoroughly made up on the question. He did not believe in the necessity of trussing, but that the outer kerb should be made sufficiently strong to enable it to maintain its shape.

What, then, are the elements calculated to cause it to alter shape? Not the gas it contains, for that exerts a pressure in all directions alike; not its rising and falling in the ordinary course of action, for if properly guided it should do so practically without friction; but the currents of the atmosphere, which exerts a great force in any direction, but only from one side at a time, which is sufficient to root up trees, to throw down houses, and which has frequently lifted gasholders out of their tanks.

The Great Central gasholders were, therefore, constructed on what I believe was an entirely new principle, and one which I have constantly followed since in gasholders of all sizes up to 150 feet in diameter, and with uniform success. This mode of construction is represented on the drawing. First there was a strong angle-iron 6 × 6; then on top of this, and forming so much of the crown, ran an annular plate, 20 inches broad and half an inch thick, and then the first of the radial top plates, a quarter of an inch in thickness, all riveted hot; then followed the remainder of the sheeting, and the whole was built on a perfectly flat scaffolding. A central pier of brickwork, with cross timbers laid horizontally at a level of 6 inches under the top of tank, was provided to receive the crown whenever the same may be let down, which will never be required till it is found necessary to get inside of the gasholder; and even then it would not be necessary, as the crown is quite as able to bear its own weight when empty as it is to bear the whole weight of the sides in addition when it is full of gas. These gasholders, four in number, have now been in action for the last sixteen years, so far as I know, with the most perfect success.

It has been suggested that gasholders constructed without roof-trussing will, when old, be less durable than those constructed with it. My answer to that is, first, that it is a matter of opinion only, and I am strongly inclined to a contrary opinion, because if the sheeting be fastened to the trussing you have a less rigid fastened to a more rigid material, and liable to the sheeting being torn at the fastenings, and this is what I have frequently seen in practice; and if the sheeting be not fastened to the trussing the whole argument of support fails.

But the wear and tear will be reduced from another cause; by avoiding the trussing we are enabled to make the gasholder heavier at those parts most liable to decay—namely, the whole of the crown sheets, and the first and last row of sides—and inasmuch as the centre of gravity of the whole mass is much lower without than with top trussing, the stability of the structure and the steadiness in a storm are much greater, and consequently straining—*ergo*, wear and tear—much less.

But there is another advantage. The weight of metal at top of holder being so much less, the gasholder not being so top heavy and thus steadier, it has much less tendency to get out of level, and the guiding standards attached to the tank need not, therefore, be so strong or so costly. The guiding standards of the gasholders at the Great Central are 53 feet high, in three pieces, and each standard weighs about 3 tons. I know many gasholders of similar diameter and height where as much weight exists in the base of the cast-iron columns, while the column itself weighs double that amount.

On the score of economy, therefore, whether in the construction of the holder or its guiding standards, the argument is all in favour of non-trussing, and this is proved by reference to some facts I have before me of the quantity of gas contained per ton of iron employed in the construction of gasholders, which I recommend to the attention of gentlemen who think that trussed gasholders are as cheap as non-trussed ones.

TRUSSED CROWNS.

Diameter.	Depth of Side.	Weight of Iron in Crown.	Iron in Sides.	Gas in Cubic Feet per Ton of Iron employed.
Feet.	ft. in.	cwt. lbs.	cwt. lbs.	
100 ..	39 0 ..	59 16 ..	40 9 ..	2992 single
108 ..	24 0 ..	26 10 ..	32 0 ..	3758 single
120 ..	22 0 ..	50 0 ..	30 0 ..	3125 single
Average 109 ..	28 3 ..	45 9 ..	34 3 ..	3292

NON-TRUSSED CROWNS.

120 ..	30 0 ..	28 0 ..	18 0 ..	7068 single
103 ..	50 0 ..	27 8 ..	26 14 ..	4577 double
149 ..	52 0 ..	28 10 ..	41 10 ..	8071 double
Average 124 ..	44 0 ..	27 19 ..	28 15 ..	6572

I do not say that, as a rule, it will be found that the difference in the cost of trussed and non-trussed holders will be so great as these figures show, because the non-trussed holders are of the average diameter of 124 feet, whereas the trussed ones are of the smaller average diameter of only 109 feet; but I would draw attention to the two first of each category—the trussed one, of 100 feet diameter and 39 feet deep, weighs altogether 100 tons, and the non-trussed one, of 120 feet diameter and 30 feet deep, weighing only 46 tons, the lighter one holding 340,000 feet of gas, the heavier one holding only 300,000 feet.

In the discussion which followed the former paper on gasholders, it appears to me that while trussed crowns had their adherents—and I know that in practice more gasholders are built with trussed crowns than without—yet the reasons given for that mode of construction were anything but weighty. One gentleman stated that the trussing served as a scaffold on which to lay the sheeting. This is the contractor's argument; and, without intending any offence, I think it simply means that "there's nothing like leather," for no one can prove that the use of a temporary timber scaffold can be anything like so costly as a permanent iron trussing. Another argument was, that as the crown should have something to rest upon when down, it was better that the holder, therefore, should carry its own truss; but this condition of things may be arrived at by attaching feet vertically to the inside, and this I have recently done in a gasholder 150 feet in diameter. The sum of the whole, therefore, is that engineers should either give better arguments or abandon a practice which they cannot better defend.

In respect of the guiding standards, I will only contrast the kind I employ with a very common kind—namely, cast-iron columns. Those which I employ are cast-iron girders, with a heavy flange on the back, and one of 3 inches broad on the face for the carriage-wheels to travel against, with an open web between, and all tied together at the top. If these are high, such as are required for telescopic gasholders, I place a second horizontal tie at about 12 inches above where the lower lift will rise to—and in large gasholders of 70 feet or upwards these ties can be straight from standard to standard without touching the gasholder—and between these I tie the standard by diagonal stays, and all those stays are constructed so as to be screwed or keyed up at one end, so that the whole can be made quite taut. I believe that by this form of construction I get the maximum of strength with the minimum of material; on the other hand, I contrast this with the system of columns shown by the drawing exhibited, which I think represents the maximum of material with the minimum of strength.

In the first place, as the strength of anything is measured by the strength of its weakest part, it is obvious that the strength of the whole column is limited to that of the tie-bar which is bolted against it to receive the wheels from whence the thrust is delivered; and, in the second place, as the columns have no horizontal or diagonal support between top and bottom, their weakness in the middle can only be remedied by an excessive amount of cast iron in the columns, which is not employing material to the best advantage. I know that columns are often used as being more pretty, but I do not think that it is the function of the engineer to sacrifice utility to beauty. Combine both, if possible, and try not to sacrifice either.

But is the column system the most eyeable? Looking at the object of the structure, I think design No. 1 is the most mechanical, and therefore the prettiest. No. 2 is more architectural than mechanical, and in point of architecture it is an anomaly, as the height of a column should be only 10 diameters; but the columns of gasholders are generally 20 to 25 diameters in height, therefore, to make them architectural, you would require to quadruple their diameter and cost. As they are, therefore, neither architectural nor mechanical, I cannot conceive in what respect they can be deemed pretty.

I would now say a word upon the action of gasholders. I dare say most of us have, at one time or other, had a gasholder that would not keep level, or that may occasionally have caused trouble. A very common cause of this I have found to exist in the want of a perfectly perpendicular path for the rollers to travel against.

If the tank is a masonry one, the tank guides are frequently made fixtures without any means of adjustment; the masonry yields to the pressure behind, and thus the guides are thrown out of perpendicular. The plan which I adopt is to build in projecting blocks of stone or timber, to receive the tank-guides; and when I have proved, by hanging down a plumb-line, that all settlement has ceased, I dress them to a perpendicular, and then attach the guides.

Then, with respect to the top standards, by constructing the horizontal and diagonal ties to key up at one end, it is easy to slacken out one or key up another, and so ensure that the standards shall be perfectly perpendicular both on side and face—a condition which it is difficult to arrive at if no such means of adjustment exist, and upon the faithful carrying out of which depends not only the satisfactory working but also the durability of a gasholder.

Trusting that enough has been said to elicit the opinions of members on a subject where practice is so various, and as we have, since the former paper on the same subject was read, had a large accession of members, I trust the subject may receive at their hands that ventilation which it merits.

Mr. PATERSON asked whether Mr. Anderson had worked out the proportions of the trussed and non-trussed gasholders in relation to the cost per 1000 feet of gas, a question which gave rise to much discussion some years ago. The *desideratum* was to adopt that principle which could be most cheaply applied.

Mr. ANDERSON said the question was partly answered by that part of the paper which stated that with trussed crowns he got an average of 3292 cubic feet of gas for every ton of iron employed, and that with non-trussed holders the average was 6572 feet. With respect to the price of trussed and non-trussed holders, he did not see why the latter should not be as cheap per ton as the former.

A MEMBER inquired whether Mr. Anderson had estimated only the timber framing necessary to support the crown.

Mr. ANDERSON said the particulars he had given were from tenders actually executed. They did not include any timber framing in the tank, but that was a very small item. He found that in trussed gasholders they did put in a central framing to support them when they came to the ground.

Mr. HAWKSLEY said he did not accept Mr. Anderson's views entirely. Of course, every engineer must act according to the particular circumstances of the case on which he was engaged. He did not by any means pretend to say that in exceptional circumstances it might not be desirable to have untrussed roofs, but he thought generally it would be better to employ a trussed roof, though it might be at a slightly greater cost. And he thought so, among other things, for the following reasons:—It very commonly happened (though rarely in this part of the kingdom) that it was exceedingly difficult to make a tight tank without taking out the whole of the earth around, and spreading the puddle, or whatever other material might be used for water tightness, upon a level bottom. In a great many instances it was exceedingly difficult and exceedingly expensive to make a tight tank without building a manual wall at the bottom, and without being at more than usual pains and cost in making the cone of earth left in the centre water-tight. Perhaps in the majority of instances perfect success was not attained. But, however, even in the cases in which success was attained, the cost of that method must be added to the cost of the untrussed crown. And in addition to that, if it was intended to have a crown equally well supported when the gasholder was in repose, there must be a very considerable wooden frame—not such a frame as he frequently observed, which allowed the crown of the gasholder to descend between the points of support and pools of water to accumulate in the hollows all over the top of the holder, which were exceedingly injurious as well as being a great eyesore. Apart from that consideration, there were others of no small consequence. In general it had been supposed—perhaps not so much of late years—that a gasholder obtained some strength from the roof, even when it was afloat. He remembered the time when it was the custom of the makers of gasholders to rivet or otherwise bind the crown of the

gasholder to the framing itself. However, the better view of the action of elastic fluids upon these plates had for many years obtained, and it was now perfectly well known that the very best thing to do was to treat the crown simply as one would treat a bladder, and to let the weight of the gasholder hanging upon the gas just expand the plate into a spherical form, and to take any radius which might be due to the configuration of the gasholder, the strength of the plates, and the other mechanical incidences and circumstances. Now, when a gasholder was so treated, as a matter of course, while it was lying upon the cylinder of gas (so to speak) it was quite independent of the frame; but not so when the gasholder was lowered, for then, in the particular mode of frame which was adopted in the ironwork of the gasholder, the crown descended upon the framing and was supported uniformly over the top, at distances of about three feet apart, and the evil consequences of that form of roof which was adopted in untrussed gasholders did not arise. But there was more than that; where a gasholder was trussed it was very convenient to give a considerable convexity to the figure of the crown. It could be done in the other case, but not so conveniently as in the case where there were timber supports. The consequence was that the radius of the crown became proportionately less, and the strength of the crown proportionately greater. The strength of a properly trussed crown was usually double, with the same thickness of metal, as that of a flat-framed gasholder, and it would be much more than that were it not for the elasticity of the iron itself and the slight yield of the riveted points, which enabled the crown to take a certain amount of rise, but not a rise at all equal to that which could more conveniently be given in the case of a trussed gasholder. Besides these considerations, there were others, such as the amount of strain which was brought upon the angle-iron or curve forming the upper part of the gasholder. In the case of a trussed roof, it was preferred to make the first plates exactly to the same curvature that the other plates were made to; they all, therefore, pulled directly, and had all an equal strain. In the case of a flat-crown gasholder, the outer plates, as in the other case, were made stronger than the others, but they were not made to the proper angle which the roof assumed when the gasholder was being raised. The consequence was there was a very unequal strain, which was certainly detrimental to the gasholder itself. Then, with regard to the weight of material, he would quite grant that in the first instance a very much lighter roof might be made by dispensing with the framing, and by giving a less convexity to the crown of the gasholder. But what happened ultimately? When the crown had become considerably corroded, there must still be enough strength left for the safety of the gasholder; but there was not that strength left, unless much heavier top-plates were employed in the case of flat, or nearly flat, roofed gasholders, than would be employed in the case of the very convexed roof of trussed gasholders. The result was—and he had no doubt about the fact, though experience as yet had not given very conclusive evidence—that trussed-roof gasholders made upon the principles which he had mentioned, and which were common in the works of the best makers, would endure very much longer than any of those more recently made flat-crown gasholders. They were safer and better in every respect, and, taking all sources of cost into account—the additional cost which usually occurred in the tank and the detached frame—he thought that little or no economy—even the first economy, and certainly no ultimate economy—was obtained in dispensing with internal trussing.

Mr. Anderson said he felt highly honoured that the ex-president had done him the favour to express his views on this question. Of course he differed from Mr. Hawksley in many of the remarks he had made, and he would briefly state what the causes of that difference were. The first objection raised by Mr. Hawksley to untrussed crowns had some reference to the difficulty of making tight tanks. He did not think there was much in that, because the amount of scaffolding employed to make a trussed crown was certainly tremendous—far more, he believed, than in non-trussed. In trussed crowns so large a quantity of strong timbers was inserted to bear the roof until it was all put together, that it was necessary to have some support from the bottom, and therefore the liability to an untight tank was equally great. The next objection was that with untrussed crowns there was a tendency to have pools of water on the top. He begged to say that was not the case when the holder was inflated. Of course, when it was let down there might be, but that was a matter of small importance. He had seen some trussed holders which were exceedingly hollow in the crown, even when inflated. He had seen some in which the weight of the central pipe had caused the roof to take a cup shape in the middle, and he had seen water lying there. Of course that need not be if the trussing were sufficiently strong. In one remark which had been made by Mr. Hawksley he was perfectly agreed—viz., that they ought to treat the crown of a gasholder as a bladder; and that he conceived was what they did with untrussed crowns. Bladders had no internal trussing, and they were more like these in form. The argument which he felt had some weight in it was, that, with a curved top, the plates themselves were formed with the proper curve. Granted; but that was what he always did. In a gasholder of 120 feet diameter, with 6-inch angle-iron, he thought it right to have the angle-iron rolled with about 3-16ths camber—*i. e.*, the outer angle so constructed that it was the same shape as when the holder was inflated. One advantage of having an untrussed crown as against a trussed crown was, that all the gas was got out when the holder was lowered, and there was, therefore, much less chance of explosion from gas and air getting mixed when it had to be repaired. Then, again, if the plates were not attached to the framing the sheeting received the most part of the strain, either in trussed or non-trussed crowns; if the sheeting was tied to the frame it was liable to be torn. He wished to know in what respect the sheeting was supported by the framing at any time; and if not, he did not see how better results could be secured from a trussed than an untrussed roof. In both cases the sheets would get corroded, and in both they would require repair.

Mr. Hawksley said, upon the last point he might, perhaps, be allowed to offer a remark. He would not attempt to go into the matter on mathematical principles, because popular discussions of this kind were not suited to questions of that character. He could not make use of formulæ so as to be intelligible in a moment, and therefore would abstain from employing them. But Mr. Anderson and he differed with regard to strength in this way—in the flat-crowned gasholder, the crown must rise sufficiently under the pressure of the weight of the gasholder to enable the crown to bring up the gasholder. Now, in that case, the tension upon the plates of the gasholder, according to the rise which the crown under those circumstances had, was more than double per square inch of the metal that which existed in a properly framed crown. The change of figure, which arose from the crown acting as a gasholder, was due in the main to the ductility of the metal, and just according as so many tons of strain were put on every inch of the plate, the plates must rise so many ten thousandth parts of an inch for every foot of the diameter. Now, it was a matter of very easy calculation to ascertain how much, under those circumstances, the crown rose, and Mr. Anderson had very properly put it, because he knew it for a fact himself (and he had within the last few weeks had a very interesting instance of the kind) that in the case of a crown of 120 feet diameter, with a pressure of about four inches arising from the weight of the gasholder, the crown would rise exactly eighteen inches. He was not now giving the dimensions which Mr. Anderson did, but a practical instance within his own knowledge. This rise was entirely due to the stretch of the metal, and of course a very simple calculation would give this result, that there was something like four or five tons per square inch put upon all the metal in the crown. Now that was a large quantity in itself, but as the crown became by-and-by weakened by corrosion it would increase to seven or eight, and ultimately to nine or ten, so that at length, unless watched and cared for and replaced at the proper moment, the crown would yield. But a crown of equal thickness to that would, supposing it rose five feet, either carry double the pressure, if that were wanted, or only have a strain upon it of about two and a half tons per square inch, and of course the weakening which took place from corrosion or otherwise would not seriously affect the stability and durability of that gasholder, at all events not in the proportion which it would do in the other case. As a matter of opinion, he believed that the crown of the one gasholder would endure three times as long, with perfect safety, as the crown of the other gasholder.

Mr. Anderson said it appeared that in all Mr. Hawksley's arguments he supposed the trussing was assisting the sheeting; but, if he understood it aright, the sheeting was laid on the trussing, and when the gasholder was inflated the sheeting did not lie on the trussing, but rose and carried it with it. Therefore he could not see the force of Mr. Hawksley's arguments.

Mr. Hawksley said, in making a framed crown, they would rarely, if ever, give a rise of less than one-twentieth of the diameter—*i. e.*, with a diameter of 100 feet they would rarely give a rise to the crown of less than 5 feet; whereas in making a flat-crowned gasholder the result would be that they could have no more rise than that which was due to the ductility of the metal put in the gasholder. It was due to that circumstance, as it appeared to him, that the one gasholder was very superior to the other. If it were not desirable, or if it were a matter of indifference that both gasholders should be made with a rise in the crown or none, then, of course, his argument fell to the ground. But, in point of truth, they were not framed upon the same principles. The one was framed with an intention that there should be a certain amount of curvature given in the construction, without any reference to the ductility of the metal; in the other case the idea was that the gasholder was to take care of itself; that it was to be, independently of the trussing, by the ductility of the metal, to take the flatter figure, and taking that flatter figure it would be strong enough for this purpose. There was no denying that it would be strong enough for a while; but, if the two gasholders were to be made of equal strength, there must be a very much larger quantity of metal in the plating of the recently constructed gasholder than in the other, and the greater part of the saving of cost, as a matter of course, vanished. But there was another material thing which had not been spoken of—viz., that in most cases in modern gasholders, and especially those of large size, a considerable pressure was wanted—a much larger pressure than in the instances of small gas-works, in which holders of small size were used. That pressure must be got in some way or other, and there was no cheaper way to get it than by means of a trussing in the crown. He knew of no instance of a properly trussed gasholder in which a greater pressure was obtained than was due to the proper construction of the holder, with a view to strength. Therefore, looking at the question from that point of view also, he inclined, without saying whether gentlemen might not legally differ from him, and especially without saying that the circumstances of each case should not govern the arrangements of the details of it, yet, as a general rule, it was, in his opinion, much better to have a trussed crown than to have an untrussed one.

Mr. Cathels thought the great bone of contention between the author of the paper and Mr. Hawksley was this, that the latter assumed throughout that in the non-trussed gasholder the crown was to be constructed originally flat, and to become convex when inflated by the yielding of the rivets and the tension of the plates; but he (Mr. Cathels) could not understand why, seeing that a permanent wooden frame was required to be left in the tank in which the crown was to rise, a non-trussed gasholder should not be constructed with a hemispherical rise of the same dimensions as in a trussed gasholder. In that case he could not see the advantage of a trussed over a non-trussed gasholder. With reference to the question of pressure, it seemed to him that it would be better, if weight were required, to get it by making the side plates a little thicker.

Mr. Esson said in a former discussion on this subject he made the remark that they ought to study the property of the matter with which they had to deal, and considering the property of gas, that its tendency when confined was to assume a spherical form, it seemed to him that that was the correct principle to be guided by in the construction of a holder. He was not sure, but he thought that with a roof frame the sheets were tied at two points, whereas in a flat roof they were tied at one point only. It appeared to him, therefore, that they gained strength by having the plates composing the roof tied not only to the top side of the gasholder, but tied also in the middle. Of course, the saving of money value was important, but it must not be taken alone as conclusive on the question whether they should construct flat or concave roofs.

Mr. Anderson said he had not found that gasholders without trussing gave too little pressure, but he had found that with trussing they would give more pressure than was necessary. He had never found it difficult to get 3 inches pressure with a gasholder 100 feet in diameter and 25 feet deep, while in the second lift he could get from 4½ to 5 inches pressure. Mr. Esson assumed that the spherical form of roof was the best, because of the tendency of gas to take a spherical form. No doubt that was to some extent correct, but the tendency of gas to take that form was only about 4 or 5 inches of a column of water; in other words, if a gasholder were turned upside down, and 5 inches of water were put in it, they would be exerting the same pressure as when it was in action. He did not say that the money cost of flat roofs should be the test, but his contention was that they could get more satisfactory results at a cheaper rate from the non-trussed than from the trussed roofs. He would say that they were, perhaps, 30 per cent. cheaper in proportion to the quantity of gas which one held to the other, and therefore it was a matter well worthy of consideration from this point of view. With regard to durability, he had found many trussed gasholders which had gone to pieces, whereas all the non-trussed gasholders were still standing. They were now sixteen years of age, and, seeing that they exhibited no defects at present, it was fair to assume they would last another sixteen years. What was the average life of a gasholder? Certainly not more than forty years. As yet it was all hypothesis about the

non-durability of non-trussed holders, and until they got the facts which experience alone could give they ought to be careful not to dogmatize on the point. None of the speakers had attacked the position that the gas-holders were better for being untrussed. He maintained that a trussed holder was much more liable, in the case of a storm to rock, from the displacement of the centre of gravity by the top load of iron rising and falling. With a flat roof also they required much less weight in the vertical guides attached to the tank. This point had not been attacked; he, therefore, assumed that it was assented to.

Mr. HAWKSLEY said the reason why nothing had been said about the centre of gravity was, he supposed, that that question did not enter into the consideration of the subject at all. If the centre of gravity could in any way be disturbed by the action of the wind, as in the case of a ship at sea, so that a gasholder could roll over 20° or 30° each way, it would be, of course, a momentous consideration. But with a gasholder the centre of gravity was practically undisturbed in any case, because the rocking never could amount to more than half an inch laterally, which practically was nothing, and the centre of gravity did not change its position at all. With regard to the leverage of the pressure of the wind, that was, of course, due exactly to the height of the gasholder, and throughout this discussion it had been assumed that the heights of the two holders were the same. If they were of the same height and diameter the pressure of the wind would be precisely the same in both cases, and in neither would the centre of gravity at any height change its momentary position.

Mr. ESSON thought the question of the centre of gravity was all in favour of trussed gasholders. If they wished a structure to resist the wind they generally added to the weight of it. In a trussed gasholder they had the whole of the weight assisting to prevent the wind blowing it over.

Mr. G. W. STEVENSON wished to know whether the gasholders at the Great Central station had been at rest since they were erected, and, if so, whether their state of rest happened to be coincident with a heavy storm of snow or rain. A test of 16 years endurance was certainly a good test for a gasholder, and he would be prepared quite to accept Mr. Anderson's views of the convenience and economy of construction on this principle provided it were fairly tested; but unless some of those gasholders had been at rest, and at rest under circumstances to try the strength of the roofs in the way he had stated, he should not be prepared to assent to the principle.

Mr. ANDERSON replied that he was not aware that the Great Central holders had ever been out of action; in a snow-storm he knew they had not. But if such a thing should happen with a gasholder of his own, whether trussed or untrussed, he should feel it right to have the snow cleared off at once.

The PRESIDENT said in consequence of the lateness of the hour it would be necessary to bring the discussion to a close.

At eight o'clock in the evening the members reassembled, and the chair was again taken by the PRESIDENT, who briefly introduced Dr. Odling as a gentleman who had done good service to the cause of practical chemistry, and had assisted in an eminent degree to promote a knowledge of the constituents of coal gas. Our report of this lecture will appear in the next number of the JOURNAL. It has been prepared for publication, but Dr. Odling's professional engagements have prevented him from giving time for its revision.

WEDNESDAY, JUNE 3.

The PRESIDENT took the chair at eleven o'clock, and, in opening the proceedings, said: Gentlemen, the committee have had under consideration the propriety of electing Dr. Odling as an honorary member of the association. Most of you were present last night, and I am sure you were much interested and instructed by the lecture which Dr. Odling delivered. I think it is a compliment we ought to pay him, and therefore I have great pleasure in proposing that he be elected an honorary member.

The motion was carried by acclamation.

Messrs. Broadhead and Stout were appointed scrutineers of the votes for the election of the committee for the ensuing year.

Mr. CATHELS called attention to the rule respecting the election of extraordinary members of the association. The rule was—"Extraordinary members shall consist of gentlemen taking an interest in matters connected with gas-works, and shall only be admitted upon being elected, at the annual general meeting of the association, by a majority of two-thirds of the members present, and they will be allowed to take part in its proceedings. Besides paying the usual annual subscription, they will pay an admission fee of £5." He believed it was the general feeling that it was not desirable to increase the number of extraordinary members.

Mr. CHAMBERS asked what alteration Mr. Cathels proposed to make in the rule.

Mr. CATHELS said he should like to take the sense of the meeting as to the advisability of striking the rule out altogether.

Mr. CHAMBERS thought there might be a danger of admitting too many extraordinary members, but he was averse to the expunging of the rule. Gentlemen might offer themselves whom the association might think very desirable, but without this rule there would be no opportunity of admitting them.

The PRESIDENT said, when the subject was brought before the committee, they felt it was not one upon which they were competent to form a judgment, and that those who considered a change or modification of the rule desirable, should bring it before this meeting, in order that an expression of the opinion of the members might be elicited. No alteration could be made at this meeting as there was no recommendation from the committee, but, if a feeling was expressed by the members generally that a change was desirable, the committee would take it into consideration, and bring up a recommendation at the next meeting.

Mr. ANDERSON thought it was a matter of some importance. He had an objection to a society calling itself what it was not. In some of the best scientific societies of London they were not sufficiently particular whom they introduced, and consequently sometimes they had gentlemen connected with them who knew more about the cut of a coat than the science of hydraulics. It seemed to him that they ought to get into this association every one who could benefit it in any way, whether they held the position of gas secretaries, managers, or, as expressed in rule 4, they were "gentlemen taking an interest in matters connected with gas-works" merely. But if they expunged this rule the preceding rule would admit those whom rule 4 now admitted, for it said "Ordinary members shall be either managers or secretaries of gas-works, who may make application for membership and be admitted." They had amongst them gentlemen who were manufacturers of gas and of gas apparatus, and this rule was practically made for the purpose of excluding persons coming into the association and canvassing for orders. He thought, while still reserving the power to introduce any gentleman who took a great interest in gas matters, they should take care to guard against the evil for which the rule was originally framed. He could see no advantage in expunging the rule, and as at present all such members must be submitted for election on the recommendation of the committee, it would be better to leave the responsibility with the committee.

Mr. CATHELS then proposed, and Mr. ANDERSON seconded, the election of the following gentlemen as extraordinary members, which was at once agreed to:—Mr. John Aird, jun., of the firm of Messrs. Aird and Son; and Mr. Thomas William Walker, of the firm of Messrs. C. and W. Walker, of Donnington.

Mr. THOMAS H. METHVEN read the following paper:—

ON THE NECESSITY AND ADVANTAGES OF REGULATION OF THE GAS CONSUMED IN PUBLIC LAMPS.

For many years public lamps have been a much neglected though an important part of the business of gas companies. The object of this paper is rather to draw attention to the subject than to introduce anything new in connexion with it.

Several reasons may be given for the neglect and apathy that have so frequently prevailed. The chief one is, that the contract system so frequently allowed so small a profit that there was no inducement to improvements that entailed any cost. The lamps were therefore lighted and extinguished at the appointed hours, and few inquiries were made by gas companies regarding the quantity of gas consumed in them, neither was much care bestowed upon the best method of getting the full advantage of the light obtainable from the gas.

The earlier lamps were badly constructed and small in size, yet the tin-work was frequently so wide as to obstruct the light which would otherwise have passed through the small and dirty panes of glass. To have removed the whole and have substituted larger and better made lamps would have been expensive, so the old pattern was adhered to, even when additions to the number were made.

The lamplighter was instructed to adjust the flames to consume 5 feet per hour. However anxious to obey his instructions, he seldom could do so. Sometimes, in order to economize gas, burners with thin slits were used, which only allowed a consumption of 5 feet per hour at the maximum pressure; of course, much less was consumed towards midnight. This burner wasted a large per centage of light, and gave rise to repeated complaints.

With ordinary burners it was quite true that all the lamps did not consume 5 feet per hour, but many more, and especially those before the lighting commissioners doors, which consumed nearly double the amount. Frequent disputes arose with the public regarding the quantity of gas consumed, in consequence of which occasionally lamps were supplied through meters. These were frequently unskilfully attached, and gave very irregular and unsatisfactory registration on that account. Again, when lighted by the company, the lamps consumed excessively, and when by the lighting commissioners the result was quite the reverse.

All confidence was lost in the lamplighter, and hence the double tap was introduced. At first a tap was placed in the upright pipe, and adjusted and placed out of the lamplighter's power. Afterwards both taps were made in one casting, one being adjusted by a key so as to allow 5 feet per hour to pass; the other tap was for the lamplighter's use.

This arrangement was a step in the right direction, although the flames were adjusted rudely by a gauge. It should have been introduced before, when a constant pressure was maintained in the mains. I recommend it now to all badly managed gas-works as better than no regulation at all. There are not a few who might at once adopt it. But wherever there is variation of the pressure, say from 20/10ths to 6/10ths after midnight, there it is useless, for if the double tap allows 5 feet to pass at the one period, it will not allow half that quantity to pass at the other.

The attempts to regulate the consumption by fixed orifices having failed, regulators were introduced. Mercurial ones were the first in the field; though correct in principle, yet in practice they were found unsuitable, being too delicate for their exposed position. Then dry governors were introduced, and to these the writer would draw attention; they have a leather diaphragm, having a conical valve attached to the under side of it, and weighted on the top side to allow the consumption required.

The regulator is fixed inside or under the lamp, and is furnished with a burner which, at 15/10ths pressure, consumes 9½ feet per hour. It is well known that a wide slit is the best for obtaining the full illuminating power from the gas consumed. At any pressure under 25/10ths the regulators maintain a uniform flame. In experiment I have found them work with 55/10ths, but I am informed by an engineer who has a hilly district—where the pressure is 34/10ths—to supply, that the pressure forces up the valve so close to the seat that an insufficient light is obtained. This defect might easily be remedied by fixing before the ordinary regulator another adjusted to give 20/10ths pressure.

Not only is there a great advantage to the gas companies resulting from the use of the regulator, but there is also a better light supplied to the public. This arises from the superior description of burner that can be used, and is usually supplied by the manufacturers of these instruments. The lamps, however, require to be more carefully constructed than formerly, as, on account of the low pressure at which the gas is consumed, there is a greater tendency to unsteadiness and smoke in the flames on windy nights.

The great difficulty in adopting improvements is in the large cost involved; yet, if a plan were resolved on, it might be carried out piecemeal at first, when lamps were repaired or new ones were erected. Then, by an extra effort, the whole might be altered to the advantage of all concerned.

A bad regulator, or an inferior one, is not worth fixing; but several makers produce excellent ones. A good regulator should be easily taken to pieces, so that new diaphragms may be inserted when necessary; it should have burners of incorrodible material secured to it by the maker, and it should be tested in this complete stage before leaving his factory.

That there is plenty of room for economy in the public lighting may easily be proved by fixing a few meters to the lamps in different parts of the town. The meters should be carefully fixed in air-tight boxes. The writer has found the consumption vary from 5 to 10 feet, and in a somewhat lengthened trial has found the average, even with the greatest care in lighting, 6½ feet per hour.

With a regulator a better light can be had from 5 feet. Thus, in a town with 300 lamps, lighted 1200 hours annually, 540,000 feet of gas might be saved. In addition to the pecuniary result, which would soon pay for the alteration, there would be this advantage, that the lighting committees and the public would have no such grounds of complaint as too frequently at present exist, and much of that ill-feeling and consequent agitation against gas companies which is so detrimental to the interests of all concerned would be prevented.

The PRESIDENT suggested that Mr. C. Hawksley's paper on the public lighting should now be read, so that the discussion of the two papers might be taken together.

Mr. CHARLES HAWKSLEY read the following paper:—

ON THE LIGHTING OF PUBLIC LAMPS ON THE SYSTEM OF AVERAGE METER INDICATION.

The necessity for the regulation of public lights having been already discussed in the paper submitted to the association by Mr. Methven, the present paper will be confined principally to a description of the method adopted in the town of Nottingham for effecting the supply of gas to the public lamps on the system of average meter indication.

Average meter indication appears to have been in use in one or two of the smaller towns in this country for a period of at least sixteen years, but was first brought prominently into public notice when applied in conjunction with the "double tap" in the town of Reading during the year 1863, under the direction of Mr. Samuel Hughes.

The attention of the Nottingham Gas Company was, in the year 1860, called to the excessive quantity of gas consumed by the public lamps, and on investigation it was found that the mean average consumption by each lamp amounted during the six months ended September 1, 1860, to no less than 7·3 cubic feet per hour, although the contract with the town authorities provided only for 5 cubic feet per hour per lamp; and during a portion of the period referred to—viz., from the 1st to the 22nd of June—the consumption per lamp was found to have attained the enormous quantity of 9·5 cubic feet per hour. The amount of gas actually consumed (as ascertained by meters attached to several of the lamps) when divided by the number of hours during which the lamps ought to have been lighted according to the lighting table, gave the results mentioned above, showing great negligence on the part of the lamplighters, who, especially during the height of summer, lighted the lamps earlier and extinguished them much later than the hours stated in the table.

It was to amend the then unsatisfactory state of the arrangements with the lighting authorities of the town that the company applied to Parliament, in the session of 1864, for an Act having amongst other objects the making of better and more effectual provisions with regard to the lighting of the public lamps. The clauses relating to this subject in the bill as introduced into Parliament were as follow:—

16.—Subject to the provisions of this Act the company shall, at their own expense, upon the request in writing of any lighting authority, provide, lay down, fix, maintain, and keep in repair all mains and service-pipes, lamp-posts, brackets, lamps, burners, stop-cocks, regulators, and other apparatus connected therewith, necessary for the proper lighting of such of the streets within the said limits as are mentioned in such request, and provided the lamps to be supplied shall be fixed at not exceeding the average distance of *eighty* yards along the course of any main to be laid down by the company for conveying gas to such lamps.

17.—The company shall, at the request in writing of any such lighting authority, supply all or any of the present public lamps within the said limits, or such other public lamps to be hereafter provided and fixed as aforesaid, with so much gas, and to be delivered at and for such times and periods as the parties on whose request the supply of gas is made may from time to time desire.

18.—The price to be charged by the company, and to be paid to them by the lighting authority, for all gas so supplied to or for any such public lamps, shall always be calculated and fixed at and according to the lowest sum per one thousand cubic feet for the time being charged by the company to any private consumer in the parish or place in which such public lamps shall be situated; but this shall not in any manner alter or affect any contract for the supply of gas to such public lamps entered into before the passing of this Act, and then subsisting, or the price to be charged and paid for the gas supplied or to be supplied under any such contract.

19.—The company shall light, clean, and extinguish all public lamps to which they shall supply gas, and the sum to be paid to the company by the lighting authority for such lighting, cleaning, and extinguishing, and for the use, maintenance, and repair of the service-pipes, lamp-posts, brackets, lamps, burners, stop-cocks, regulators, and other apparatus as aforesaid, shall be *sixteen* shillings per lamp per annum, payable quarterly.

20.—Notwithstanding anything hereinbefore contained, the quantity of the gas supplied to the public lamps under any contract hereafter made shall, at the option either of the company or of the lighting authority, be ascertained during the period of any such contract by meter, and in such case the necessary meters shall be provided, and fixed and kept in repair by the company, at the expense of the party requiring the same.

21.—The company shall, within *six* months after the passing of this Act, pay to the lighting authority such sum of money, by way of compensation, as may be agreed upon between them as the reasonable value of the lamp-posts, brackets, lamps, and the fittings and apparatus connected therewith, belonging to and used by such lighting authority; or in case any difference shall arise as to such value, the same shall be settled by arbitration, in manner provided by the clauses of "The Companies Clauses Consolidation Act, 1845," with respect to the settlement of disputes by arbitration; and at the termination of the current quarter in which the payment is made, the lamp-posts, brackets, lamps, and the fittings and apparatus in respect of which the payment is so made, shall belong to the company; and any sum of money agreed on or awarded to be paid, together with the cost of the reference (if any) as settled by the arbitrators under the provisions of the said Act, shall be paid out of the reserved fund of the company.

The bill was opposed by the corporation and the lighting authorities of the town, and after a severe contest before a select committee of the House of Commons, during which certain alterations were made in the clauses affecting the regulation of the public lamps, the Act was passed with the following clauses:—

15.—Subject to the provisions of this Act the company shall, at their own expense, upon the request in writing of any lighting authority, provide, lay down, fix, maintain, and keep in repair all mains necessary for the proper lighting of such of the streets within the said limits as are mentioned in such request, and provided the lamps to be supplied shall be fixed at not exceeding the average distance of eighty yards along the course of any main to be laid down by the company for conveying gas to such lamps.

16.—The company shall, from time to time, at the request in writing of any such lighting authority, supply all or any of the present public lamps within the said limits, or such other public lamps to be hereafter provided and fixed as aforesaid, with so much gas, and to be delivered at and for such times and periods as the parties on whose request the supply of gas is made may from time to time desire.

17.—The price to be charged by the company, and to be paid to them by the lighting authority, within the extended limits by this Act authorized, for all gas so supplied to or for any such public lamps, shall always be calculated and fixed at and according to the lowest price for the time being charged by the company to any private consumer in the parish or place within such extended limits in which such public lamps shall be situated.

18.—The gas supplied to the public lamps within the limits of this Act and the recited Acts shall be consumed by meter, at the option, from time to time, of the lighting authority or the company; and in case of its being consumed by meter, the meters shall be provided by the company at the expense of the lighting authority, but neither party shall, except as hereinafter provided, be entitled to require that a meter be affixed to more than one in every twelve lamps then supplied with gas under this Act or the recited Acts: provided also, that the company shall be at liberty, if they think fit, to have a meter affixed to any additional number of lamps, they providing such meters, and paying to the lighting authority the additional expense of providing and adjusting the lamps, lamp-posts, and other things necessary for their reception and use: provided always, that if the gas shall, under the provisions of this Act, be supplied to the public lamps by average meter indication, the company shall, for securing uniformity of consumption between the metered and the unmetered lamps, from time to time provide the public lamps under the control of the lighting authority with proper regulating apparatus and burners to the satisfaction of the lighting authority, or, in case of difference, as from time to time shall be settled by the justices in petty sessions assembled.

19.—The average amount of the indications of all the meters attached to the public lamps under the control of any lighting authority shall be deemed to be the amount consumed by each such lamp.

20.—The gas supplied to any such public lamp shall be permitted to pass unrestricted to and from such regulating apparatus for the whole of the period during which any such public lamp shall be lighted.

Subsequently, Mr. Hawksley, the engineer to the gas company, was instructed to take the necessary steps for the introduction into the town of Nottingham of the system of average meter indication, and with the assistance of Mr. William Sugg, he devised the modified form of meter and the burner-cock now in use, with the view to overcome some of the difficulties which had previously been encountered where that had been tried. The lamps at Nottingham were first lighted on the system of average meter indication in the beginning of the year 1866, since which, and up to the present time, that method of lighting has been maintained in operation without interruption. The apparatus employed is as follows:—

1. Every lamp throughout the town is furnished with a governor, above which is fixed a brass cock and steatite burner.
2. One lamp in twelve has, in addition to the above, a wet meter placed underground, near the foot of the lamp-column.

The meter is of the compensating class, and, in order to reduce the friction to a minimum, the drum is made of the same diameter (about 12 inches) as that of an ordinary 5-light meter, but is so diminished in width as to have the capacity of a 3-light meter only, it makes eight revolutions for each cubic foot of gas measured, and requires to work it a pressure of only half a tenth of an inch when passing 5 cubic feet of gas per hour.

The waste-water box is so arranged as to be capable of being emptied by means of an exhausting syringe introduced through a plug-hole in the top of the meter-case.

The index is placed horizontally on the top of the meter, so as to be visible on raising the cover of the cast-iron box in which the meter is placed. The index at first employed was made of brass, and of the ordinary pattern; but great trouble being given by the meters ceasing to register, it was discovered that the condensation in the dial box due to changes of temperature, and probably in some measure also to the evaporation from the water in the meter, corroded the wheelwork to so great an extent as to cause the breakage of the teeth of the wheels, and consequently to permit the passage of the gas without registration. It was then determined to make the indices with strong wheelwork of gun-metal, afterwards tinned to preserve it from corrosion, and a simplified arrangement of index suggested by Mr. Henry T. Humphreys was used, consisting of two large wheels, each about 4¼ inches in diameter; both wheels are worked by the same pinion fixed on a vertical shaft, which is driven in the usual way by a worm on the drum-shaft. One of the large wheels is provided with 202 teeth, and is attached to a revolving dial-plate, the circumference of which has 100 divisions, each representing one cubic foot of gas, indicated by means of a fixed pointer. The other large wheel is furnished with 200 teeth, and has attached to it a hand also pointing to the before-mentioned divisions on the dial-plate, each of which now represents 100 cubic feet; but the number of teeth in this wheel being two less than those on the wheel to which the dial-plate is connected, the hand revolves somewhat faster than the dial-plate, and thus indicates every 100 cubic feet of gas consumed up to 10,000 cubic feet, beyond which it is unnecessary to record in meters of this class. As a further precaution against corrosion, the index-box is filled with refined oil to the level of the under side of the dial-plate, and with the index thus made and protected no further difficulty has been caused through the meters having ceased to register.

The freezing of the water during the winter has been effectually prevented by the introduction into each meter of a small quantity of methylated spirit. This was at first found to interfere with the proper action of the meter, and it was then discovered that the spirit as ordinarily sold is mixed by the Customs authorities with gum to prevent its use for the purpose of defrauding the Excise. Unadulterated spirit was afterwards obtained, on a certificate being given to the authorities as to the use to which it was to be applied, and no further inconvenience has been experienced. Additional protection against frost is afforded by filling with felt the space between the two covers of the meter-box.

The meter is placed in a cast-iron box let into the ground near the foot of the lamp-post, so that the cast-iron lid (which is hinged) is level with and forms part of the foot pavement; beneath this lid is a false cover of iron to afford additional protection to the meter, which cover may, if required, be tightly screwed down on to an india-rubber washer, thus forming a water-tight joint and keeping the interior of the box dry even when immersed in water. Apertures are left in the back of the box through which to pass the inlet and outlet pipes, and these are made water-tight by means of washers and back nuts.

After having passed through the meter, the gas ascends by a pipe placed in the usual manner in the lamp-column until it reaches a brass cock placed between the top of the post and the under side of the lantern. This cock is opened and closed by means of two short brass arms, curved downwards, so as to be readily caught by the end of the lighting torch. The plug is made longer than usual, for the purpose of securing tightness and resisting the blow of the lighting torch when used with rapidity, and the stops are so placed that the plug cannot make more than a quarter of a revolution. This arrangement ensures the opening of the cock to the full extent whenever the lamp is lighted, without requiring care on the part of the lamplighter, who has merely to push up the lever as far as it will travel, and who would, indeed, have some difficulty in opening the cock only partially were he even disposed so to do.

Immediately above the cock, but inside the lantern, is placed the governor, an instrument without which the system of average meter indication could never have been satisfactorily adopted. The governor in use at Nottingham is the one made by Mr. Sugg, which is so generally known that it is almost unnecessary to state that it is of the kind called a dry governor, and consists of a leather diaphragm from which is suspended a cone which regulates the size of the aperture admitting the gas to the under side of the diaphragm, and can by means of weights be so adjusted as to give any required pressure at the burner, the stem of which is screwed on to the top of the governor. The burner is a bat's-wing, formed of steatite and placed at the upper end of a brass stem made of unusual length, with a view to prevent the heat of the flame injuring the leather of the governor, to diminish to an almost imperceptible amount the shadow which would otherwise be thrown on the pavement by the governor, and to obtain a regular flow of the gas before it reaches the point of ignition, a matter of some moment where it is desired to have a steady flame.

Meters are, as has been already stated, attached in the case of Nottingham

to one lamp in twelve, the lighting authorities having elected to have that proportion, although the gas company were willing to adopt one in twenty; it is, consequently, of the utmost importance that the governors and burners of any one series of twelve lamps should each be accurately adjusted to consume an equal quantity of gas, otherwise the metered lamp would cease to afford a correct indication of the consumption of the whole of the remaining eleven lamps. The governors, with their burners attached, are therefore, in the first instance, separately adjusted to a consumption of 5 cubic feet of gas per hour; they are then placed twelve in a row, and are again tested for an hour, when, if the total consumption during that time is found to be 60 cubic feet, they are issued for fixing to the lamps, the governor and burner for the metered lamp being taken indiscriminately from the set of twelve. Care is, however, taken to keep each set distinct, and in the event of any future readjustment or repair being required to the governor or burner of any one of the set, the remaining eleven are also removed from the lamps, and the whole are again tested together before being refixed. With these precautions no difficulty is experienced in maintaining uniformity of consumption in both the metered and the unmetered lamps.

Having described the apparatus in use at Nottingham, it will now be shown with what results the application in that town of the system of average meter indication has been attended. The public lamps have been supplied on that system for nearly 2½ years, but as some months of that period were necessarily occupied in bringing the system into perfect operation, the results given will be confined to the eighteen months ended March 31, 1868, that being the date of the last quarterly return of the indication of the meters.

There are within the town of Nottingham about 860 lamps, to 72 of which meters are attached; this is exclusive of places without the town in which the system is in operation, and where the results are similar to those obtained within the town. The indices of the meters are recorded monthly, and returns are made both monthly and quarterly showing the situation of each metered lamp, the state of the index, the number of cubic feet of gas consumed during the period, the number of hours during which the lamp was lighted, and the consumption per hour by each lamp.

The following table shows the results of the eighteen months working. In order to economize space the indications of seven only out of the 72 metered lamps are tabulated in detail, but it should be stated that the instances given have not been specially selected, but that every tenth metered lamp has been taken for illustration exactly in the order in which it happened to stand in the quarterly return of the company, as would be at once apparent by a comparison of the table with the company's printed form of returns:—

TABLE *showing the Results of the System of Average Meter Indication as applied to the Public Lamps within the Town of Nottingham, during the Eighteen Months ended March* 31, 1868.

Number of Metered Lamp.	Situation.	Consumption in Cubic Feet per Hour, for the Quarter Year ended						Consump. in C. Ft. p. Hour at each Lamp on Average of 18 Months.
		1866.	1867.				1868.	
		Dec. 31.	Mar. 30.	June 29.	Sept. 30.	Dec. 31.	Mar. 31.	
10	Newdegate Street . .	4·54	4·74	4·86	4·71	4·56	4·72	4·68
20	Park Row	4·15	4·37	4·49	4·55	4·47	5·00	4·50
30	Wilford Road. . . .	4·69	5·02	5·05	5·20	4·88	4·90	4·95
40	Canal Street	3·70	4·19	4·49	4·67	4·56	4·45	4·37
50	Robin Hood Street . .	4·23	4·46	4·68	5·20	4·64	4·63	4·64
60	Vicarage Street . . .	4·23	4·56	4·86	4·87	4·88	4·63	4·67
70	Stoney Street	4·38	4·56	4·68	4·55	4·31	4·27	4·45
Average consumption per hour of the above 7 lamps during each quarter year		4·27	4·55	4·73	4·85	4·61	4·65	4·60
Average consumption per hour of the 72 metered lamps within the town of Nottingham during each quarter year		4·32	4·64	4·71	4·86	4·69	4·68	4·65
Maximum consumption per hour of any of the 72 metered lamps within the town of Nottingham during each quarter year . .		4·85	5·3	5·24	5·36	5·29	5·27	—
Minimum consumption per hour of any of the 72 metered lamps within the town of Nottingham during each quarter year . .		3·70	4·09	4·11	4·22	4·15	4·27	—

It will not fail to strike the members of the association how closely the average results of the 18 months consumption of gas by the seven lamps given in the table in detail corresponds with the average consumption during the same period of the whole of the 72 metered lamps within the town, being in the one case 4·60 cubic feet per hour, and in the other case 4·65 cubic feet per hour, showing that almost precisely the same result would have been arrived at had the meters been applied to 1 lamp in 120 instead of to 1 in 12. Indeed, had it not been for some unusual irregularity in the burning of metered lamp No. 40 during the quarter year ended December 31, 1866, the average hourly consumption of the seven lamps would probably have been exactly equal to that of the 72 lamps. It would, however, in practice probably not be prudent to attach meters to fewer than 1 lamp in 25, in order not only to obtain security against fraud on the part of the lamplighters, but also to give satisfaction to all parties concerned, and to provide for a correct average being obtained in the event of the stoppage of any of the meters employed.

In calculating the quantity of gas consumed, the registration of all meters which have ceased to work, or which from leakage, breakage, or other cause, have manifestly not afforded a correct return, should be rejected; the sum of the quantities recorded by the remaining meters should then be divided by the number of such last-mentioned meters, and the average consumption per lamp thus obtained being multiplied by the total number of lamps (both metered and unmetered) in the town or district supplied, the result will be the total quantity of gas consumed by the public lamps during the period in question.

Nottingham having been, it is believed, almost the only town in which the supply of gas to public lamps on the system of average meter indication has been attempted with success, it may be desirable to consider shortly the causes of failure in most of the places in which the system has hitherto been tried. They appear to have been principally the following:—

1. The employment of too small a meter.
2. The use of dry meters.
3. The want of governors.
4. The attempted adjustment of the consumption by means of the double tap.

1. The employment of a small meter, whether wet or dry, necessarily causes a considerable diminution of pressure at the governor; and as in many cases such diminution of pressure cannot be afforded without putting the governor out of action, it follows that in such instances the consumption of the metered lamps will be less than that of the unmetered lamps.

2. The dry meter is especially unsuited for public lamps, owing to the traffic in the streets causing a vibration of the valves, which permits leakage, apart from the question, so much discussed, of the comparative merits of the wet and dry meter for ordinary purposes.

3. Where the average meter system is applied without governors or regulators of any kind, not only does the lamplighter become the judge as to whether the flames are so adjusted as to consume equal quantities of gas at the metered and the unmetered lamps, but even were it possible for him to adjust the flames with the requisite degree of accuracy at the time of lighting the lamps, which is the time when the pressure of the gas would be the greatest, as the pressure decreased the consumption of the metered lamps would decrease more rapidly than that of the unmetered lamps, owing to the friction of the meter remaining constant; thus, supposing the pressure of the gas at the time of lighting to equal 16/10ths of an inch of water, and the friction of the meter to equal 2/10ths of an inch, the pressure at the burner of the metered lamp would be 14/10ths of an inch, or 7/8ths of the pressure at the burner of the unmetered lamps; then assuming the pressure to be reduced during the night to 8/10ths of an inch, the pressure at the burner of the metered lamp being still reduced 2/10ths of an inch by the friction of the meter, would become 6/10ths of an inch, or only 3/4ths of the pressure at the unmetered lamps, instead of 7/8ths of such pressure as at the time when the flame was adjusted. That less gas would consequently be consumed at the metered than at the unmetered lamps will be at once apparent.

4. It has in several towns been attempted to adjust the consumption at the lamps by means of the double tap, but necessarily with very imperfect results, for although by means of the double tap it may be possible to adjust the consumption with greater accuracy than when done merely by the eye of the lamplighter, it is open to the same objection as the preceding case, in so far as the decrease in the pressure of the gas causes a greater decrease in the consumption of the metered lamps than in that of the unmetered lamps. The double tap does not in anywise act as a governor, and consequently, if adjusted so as to afford a supply of 5 cubic feet per hour when the pressure in the main-pipes is at the maximum, it will give a considerably smaller supply when the pressure is reduced during the night; the amount of light will be variable, instead of being, as is the case where governors are employed, the same throughout the night, however great may be the variations in the pressure in the main-pipes.

The president of the Association has kindly permitted the insertion in this paper of the following results of some careful experiments made by himself and Mr. Hughes, on double taps and on governors, at Folkestone:—

Series No 1.

Experiments on Twelve Double Taps (adjusted *in situ*) and Twelve Regulators, in Sandgate Road, Folkestone, with a Meter attached to every Lamp, and a second Meter to Lamp No. 6.

Mr. Hughes's Double Taps.	Consumption per Hour.	*Sugg's Regulators.*	Consumption per Hour.
No. 1	2·54	No. 1	3·04
2	3·46	2	3·25
3	2·96	3	2·66
4	3·12	4	2·58
5	6·70	5	3·91
6 (metered lamp)		6 (metered lamp)	
7	4·29	7	3·04
8	5·00	8	2·71
9	6·04	9	3·21
10	3·37	10	3·46
11	2·58	11	3·00
12	2·50	12*	—
Average	4·04	Average	3·03
No. 6—Double tap, with two meters interposed	3·21	No. 6—Regulator, with two meters interposed	3·00
Average excess per hour of consumption of unmetered over metered lamp	0·85	Average excess per hour of consumption of unmetered over metered lamp	0·03
Average excess per cent. of consumption of unmetered over metered lamp	26·48	Average excess per cent. of consumption of unmetered over metered lamp	1·00

* The burner of this regulator was so broken in carriage that it could not be used.

Series No. 2.

Experiments on the Double Taps and Regulators, at Folkestone, removed from the Lamps in the Sandgate Road, and tested by a Gasholder containing One Cubic Foot adjusted to the Day Pressure at the Stand-Pipe of each Lamp.

Mr. Hughes's Double Taps.	Consumption per Hour.	*Sugg's Regulators.*	Consumption per Hour.
No. 1	2·628	No. 1	3·270
2	3·438	2	3·180
3	2·976	3	3·132
4	3·102	4	3·078
5	7·332	5	3·192
6 (metered lamp)		6 (metered lamp)	
7	4·728	7	3·330
8	5·652	8	3·114
9	6·342	9	2·820
10	3·156	10	3·420
11	3·174	11	3·336
12	2·520	12 (was damaged and not fixed)	
Average	4·095	Average	3·183
No. 6—Double tap, with a meter interposed, per hour	2·916	No. 6—Regulator, with a meter interposed	3·012
Average excess per hour of consumption of unmetered over metered lamp	1·179	Average excess per hour of consumption of unmetered over metered lamp	0·175
Average excess per cent. of consumption of unmetered over metered lamp	40·43	Average excess per cent. of consumption of unmetered over metered lamp	5·82

The extracts given below, from a series of experiments made by Mr. Sugg on the double tap, will also illustrate its inapplicability to the system of average meter indication.

Experiments with the Double Cock.

Double Cock adjusted for a Consumption of 5 Cubic Feet per Hour with a Pressure of 7⅓10ths of an Inch.		Double Cock adjusted for a Consumption of 5 Cubic Feet per Hour with a Pressure of 3 Inches.	
Pressure of Gas.	Consumption in Cubic Feet per Hour.	Pressure of Gas.	Consumption in Cubic Feet per Hour.
5/10ths	3·8	3/10ths	2·1
7⅓10ths	5·0	7⅓10ths	2·45
1 inch	6·1	1 inch	2·8
1¼ ,,	6·8	1¼ ,,	3·15
1½ ,,	7·5	1½ ,,	3·5
1¾ ,,	8·2	1¾ ,,	3·8
2 inches	8·9	2 inches	4·1
2¼ ,,	9·5	2¼ ,,	4·3
2½ ,,	10·0	2½ ,,	4·5
2¾ ,,	10·7	2¾ ,,	4·75
3 ,,	11·1	3 ,,	5·0
3¼ ,,	11·6	3¼ ,,	5·25
3½ ,,	12·0	3½ ,,	5·5

In conclusion, it is hoped that the foregoing description of the apparatus employed in the lighting of public lamps on the system of average meter indication as applied at Nottingham, and the account of the actual working of the system in that town, may prove to be of some value to those members of the British Association of Gas Managers who may now or hereafter have occasion to conduct the supply of the public lamps by this method.

The PRESIDENT said there could be no doubt of the great value of the two papers just read, and the association were much indebted to the authors of them. Mr. C. Hawksley's paper contained much information of a highly practical character.

Mr. C. HAWKSLEY, in reply to an inquiry as to the altitude of the various lamps mentioned in the table attached to his paper, said they were at various elevations. Those in Canal Street were in the very lowest part of the town adjoining the railway station, and on the level of the canal, whilst those in Park Row and Robin Hood Street were in higher parts of the town. As being connected with the subject under discussion, he might mention that an instrument had just been brought out by Mr. Sugg for measuring exactly and indicating by means of electricity and clockwork the amount of gas consumed per hour by a regulator. The instrument, which was exhibited on the table, was a very simple one, arranged somewhat on the principle of a printing telegraph. It consisted of an experimental meter, showing the consumption per hour in experiments of one minute's duration. Attached to the drum-shaft of the meter was a disc provided with little points which formed a contact with an electric battery whenever a 1-60th part of a cubic foot of gas had passed through the meter. To the clockwork was connected a drum, upon which was wound a paper tape drawn beneath a small punch, also actuated by the clockwork, and caused to descend every minute, and so to punch a hole through the paper near to the inner edge. Exactly opposite the punch attached to the clockwork was placed another similar punch, acted upon by an armature in connexion with the electrical apparatus before mentioned, so arranged as to puncture the tape on the outer edge every time contact was made by any of the points on the disc attached to the drum shaft of the meter; therefore each hole represented 1-60th part of a cubic foot of gas passed through the meter, or one cubic foot of gas per hour, in observations of one minute's duration. If the distances between these holes agreed, there was just one foot of gas being consumed by the governor; if five holes occupied the same space in length as one space marked by the clock, then there were 5 feet of gas per hour being consumed by the governor. The intention was that the governor should be attached to the pipe connected with this meter, and the clockwork being started, the governor was left alone to burn whatever quantity it would. It might be left burning for several hours, and on examination of the paper, if the marks of the consumption and of the minutes did not agree—the one over-running the other—it would show that the governor was passing too much or too little gas. It was then a very easy matter to regulate it until it passed the exact quantity desired.

Mr. WHITE, of Birmingham, in response to a call from the chair, said he had had very little experience in connexion with the public lighting of that place, this department being conducted at the office. He believed it was satisfactory, except that the use of dry meters was being discontinued by the corporation, he could not say from what cause.

The PRESIDENT inquired how many public lamps there were in Birmingham.

Mr. WHITE replied about 5000. The average meter system had been applied throughout the town—one meter to 12 lamps.

Mr. DOUGLAS expressed the opinion that small meters would not be found to answer. For five or six years he had 3-light meters in the Phœnix Company's district, but finding they would not go regularly, he had them changed for 5-light meters.

Mr. MILES, of Tyldesley, said the application of meters to lamp-columns seemed to be an easy matter, but he thought there would be some difficulty in applying them to brackets. In the district from which he came they were all bracket-lamps. Looking to the cost of the cast-iron box, he thought it would be well to arrange for placing meters in the cellars of adjoining houses.

Mr. JOHNSON said he had had some little experience, in connexion with the Chartered Company, of the working of meters and metered lamps in the City of London, and he must say, as the result of his experience, that his opinion was very much against the adoption of the average meter system. He had found that there was an obstruction in meters, however correct; and where the company was subject, as his company was, to frequent deposits of naphthaline, there was a greater liability to that deposit in the fittings of the lamps to which meters were attached than to the others, and, of 'course, in such cases, the meters worked slow. In some instances he had tested the other lamps, and found that they were consuming considerably more than the metered lamps indicated; although the meters, perhaps, on examination on the test-table, were proved to be correct. He attributed this to the fact that the lamps they supplied were in streets where there was a great deal of heavy traffic, and, as the meters were fixed in the lamp-columns, their valves were in a continual state of agitation, which allowed minute quantities of gas to pass unregistered. With respect to the question of bracket-lamps, there was a great difficulty arising, especially from the greater tendency to a deposit of naphthaline in the horizontal pipe. On a sudden change of temperature they had sometimes had a number of lamps reported by the police to be extinguished, or giving but a feeble light, and upon examination nearly the whole of these were found to be bracket-lamps, and the defect arose from a small film of naphthaline stopping up the orifice of the horizontal pipe. To a certain extent that difficulty had been got rid of by introducing a cock with a horizontal lever directly under the bracket.

Mr. BATES said in his town the authorities, desiring to try the meter system, fixed upon three different levels in the town for the purpose of fixing them. Their contract with the gas company was for 5 cubic feet an hour; the result of the testings showed that at the lowest level the consumption was 5 feet; at the middle level it was 6½; and at the highest level 9 feet. As to bracket-lamps, he had not found any difference in them.

Mr. ELDRIDGE thought the difference between the bracket and column lamps arose from the tubing in the former being generally small. At Richmond they had experienced difficulty in that way, and found it arose from the smallness of the fittings.

Mr. MARTIN said that at Ormskirk they had tried the meter system, and found it succeed very well. One reason it was discontinued was that they were satisfied with the double tap without meters, and he thought the experiments at Nottingham showed that they might all be satisfied with the regulator without meters. Another reason for discontinuing the meter system was that the company wished the local board to bear the expense of making proper receptacles for containing the meters. They tried to get accommodation for them in the cellars of houses, but the owners or occupiers required them to pay a rent for the same.

Mr. STEVENSON said they had between 3000 and 4000 lamps in Dublin supplied on the average meter system, which they found to work extremely satisfactorily. The corporation were satisfied that they had effected a considerable saving in the expenditure; the company were satisfied that they had effected a considerable saving in the unaccounted-for gas. They had tried the system for eighteen months, and he was convinced that the general adoption of it was only a question of time. Gas companies would ultimately find it was to their interest to induce the local authorities to agree to it wherever practicable.

Mr. HAWKSLEY said the circumstances under which the system became introduced at Nottingham, and under which it ultimately became perfected in the manner described by Mr. C. Hawksley in the paper just read, were somewhat remarkable. The experiments ending in the adoption of this system began so far back as the year 1842, when the company, being applied to to light certain lamps placed in a very extraordinary situation and under very extraordinary regulations, thought proper to apply meters to those lamps, for the purpose, not of making a charge, but solely for gaining information with regard to the consumption. It so happened that at Nottingham this was the absurd and ridiculous state of things which continued for many years—ever since the year 1820—under the special Act of Parliament of the Lighting Committee—that whereas the gas company were bound to supply gas, the Lighting Committee had the privilege of lighting the lamps and otherwise dealing with the gas as they thought proper. This, it could be easily imagined, led to a considerable amount of over consumption, arising not merely from the irregular magnitude of the burners, but also from the irregularity of the hours at which the gas was lighted and extinguished. It so happened, too, that the Lighting Committee was (and still continued to be, though under somewhat different circumstances) a popularly elected body, and that the lamplighters themselves were the parties who elected their masters—a most extraordinary and anomalous state of things. They always had cards containing a list of the members of the Lighting Committee whom they wished to have annually elected; they went about canvassing, and they even subscribed money among themselves to secure the election of their friends. As a matter of fact they did secure their election, and of course their masters at that time of day had no control over them, for, when masters were elected by their servants, it was not very likely the servants would be perfectly obedient to the behests of their masters. The result was, the consumption of gas became enormous, and uselessly so. The lamps were lighted very early in the evening, quite irrespective of the terms of the contract, and were put out very late in the morning—frequently, as he had himself observed, they were burning several hours after daylight, particularly in summer time. The company therefore applied more meters, and they applied them in situations with which the lamplighters were not acquainted, or which they had forgotten. The result was, that they found in some cases, while they were paid under the contract for 10 hours a night and 5 feet per hour, as much as 11 feet were consumed per hour in some cases, and in others 7, 8, and 9 feet, and upon the whole, so far as they were able to ascertain under the then existing circumstances, the consumption averaged 6 or 7 feet per hour. This was of course a great tax, not upon the company, because they were able to pay the dividend secured to them by Act of Parliament, but upon the private consumers, because, in consequence of this great and useless waste of gas, the price of the article supplied to them was obliged to be kept up higher than it otherwise would have been. However, a few years ago the company took grace of heart, and determined to apply to Parliament for the purpose of enforcing average meter registration all over the town; and it was the only instance, to the best of his knowledge, in which a company had determined to and had been successful in turning the tables upon the local authorities. After hearing the case of the gas company—and the bill was opposed before the committee for about eleven days, costing a large sum of money, and resisted by the very persons who have been most urgent and anxious in other cases to promote average meter registration—the company obtained from Parliament what they wanted; and they did more than that—and it was to that he wished immediately to draw the attention of the meeting—along with that they got an absolute price fixed, a price which was to be "equal to"—not as in many cases it was improperly provided, "not exceeding,"—the actual price charged to the largest private consumer. In this way the Act worked beneficially to all parties. The Lighting Committee knew what they had to pay; there was no arbitration, no quarrelling. The company had a graduated scale of rates, by which the price was reduced according to the consumption, and the Lighting Committee paid exactly the lowest rate; so that there was an end of a tormenting question which had never before been satisfactorily solved during the 30 years previous to the passing of the Act. He mentioned this as many of the members were from time to time going to Parliament, in order that they might adopt a similar clause, and not have a clause which said that the company should charge the public lamps at a rate "not exceeding the price paid by the lowest private consumer," because that, of course, left the whole question open. It imposed a maximum price of a minimum order upon the company, and left the squabble of what was to be the lowest price from time to time. They never had anything of that sort now in Nottingham, and the result was, that justice was done to the private consumer, who got the benefit of the amount which was fairly paid for the supply to the public lamps. The company had no additional benefit in it; they got their maximum dividend, which was a very moderate one, but their duty was solely to see that justice was done between the public and the private consumers. Parliament, at the company's instance, took the question out of their hands, and settled it once for all, which was a matter

of great consequence. But then came the application of this system, which was proceeded with immediately after the passing of the Act. Just at that time it had been arranged, contrary to what had been done before, that the company should light the lamps. The company did that, but they were obliged to employ the same lamplighters, and to conduct their business pretty much upon the same footing as it had been previously conducted. No satisfaction arose from that. The company still found, upon examining the meters they had applied in various places, that the lamps were taking 6½ feet instead of the 5 feet per hour which was the quantity they were being paid for. They therefore considered that the time had arrived to make a new arrangement under the Act of Parliament, and to insist upon average meter consumption. They told the committee, "You may light the lamps if you please—you may deal with them just as you like—but we will be the suppliers of gas upon that system, and that system only." Thereupon the Lighting Committee reassumed the control of the matter, but under very different circumstances. They found that after the company had applied the apparatus it did not answer their purpose nor the purpose of the town to continue the old lax system. They, therefore, adhered strictly to the cards of lighting, and the men now gathered their ladders from one, or at most two particular places, where the moment of taking them out was recorded by an inspector kept by the committee for the purpose, and so also with regard to extinguishing the lamps; so that now, instead of the lamps being lighted much before the proper time, and extinguished much after the proper time, the duty was performed at the stipulated hours. In fact, the lamplighters were no longer masters of the situation. The company supposed, when a new contract was entered into, that the Lighting Committee would insist upon having at least the whole 5 feet per hour mentioned in the contract, and they therefore adjusted the governors, as they thought it would please them, to $5\frac{3}{10}$ feet. All at once the committee discovered that this would not suit their book at all, and so they insisted that the company should adjust the governors to a quantity not exceeding 5 feet. They were therefore now adjusted to about $4\frac{8}{10}$ feet. The consumption, on the average of the lamps referred to in the table, appeared to be only 4·65 feet; but that did not arise from any irregularity in the adjustment, but simply from the fact that the lamps were not lighted quite the full time on the cards. The inspector of the Lighting Committee went round with the company's man and took the state of the meters, and, if any meter was stopped or had fallen out of order, that meter was struck out of the list, and of course the number of meters in use was counted the less by that one than otherwise it would be. The average was obtained by taking all the meters which had worked for the quarter, and so well was the system applied that there was scarcely any which had to be thrown out of account. With regard to the system itself, which he believed had failed in the great majority of cases, the success in Nottingham was entirely due to two or three very simple things. One was that they employed wet meters, and wet meters alone. Dry meters were wholly and entirely unfit for the purpose of measuring the gas supplied to the public lamps, and particularly so if they were put into the lamp-posts. He did not himself attribute much of the defect of the meter to the disturbance caused by the shaking of the ground, although that was a very prevalent opinion. But, if there was any little quantity of naphthaline deposited in dry meters, it was almost sure to raise the valve, and the valve then worked improperly, and was leaky. Besides that, the lamp-posts, especially in summer, were always highly heated. The temperature of lamp-posts frequently rose to 120° or 130°, and no leather would stand that. Then again, in winter the leather became very stiff, so that the meter worked awkwardly and sometimes not at all. Nothing of that kind happened with the wet meter. All that was required was that the wet meter should be put in the ground, where of course it was exposed to a certain amount of frost, but not to the same extent it would be if above ground, and to charge it in part with a little methylated spirit, or what perhaps was better, a little glycerine, to prevent the water from freezing. The meter then travelled perfectly well, whatever might be the temperature of the external air. But, besides this, it was found necessary that the drum of the meter should have a great leverage. Consequently, at Nottingham they used a 5-light drum—diminished, it was true, in width, but having a considerable radius. The pressure of the gas was capable of moving a drum of this kind with almost no sensible pressure. The next thing to be considered was the governor, and he might say that the governor, as now made, was perfectly satisfactory, and regulated the gas with the greatest delicacy. The governors at Nottingham were manufactured by Mr. Sugg, and were all regulated to 6/10ths of an inch. In no part of the town was there a pressure so low as 6/10ths of an inch, therefore the regulating action of the governor was always being applied. Below the governor there was a cock placed of a very simple description. It had two arms to which the lighting torch could be applied, and the gas was turned on and turned off with the greatest possible ease; and there was this in it, which was a most important part of that little contrivance, that it did not, when lighted from below, admit of being manipulated so as to admit of less gas passing through the metered lamps than through the others. Where lamps were lighted with a ladder, and the cocks could be manipulated with the fingers, the man could so turn them as to give a few feet less in the metered than in the unmetered lamps. But he could not do that from below; he could give no adjustment whatever, and consequently the supply was regulated not by the cock but by the governor, and as the governor was properly adjusted, it followed that the company got paid for the exact quantity of gas consumed, which was the main thing, after all. Something was said about these governors being expensive. On the contrary, they were very cheap; they did not cost more than 3s. each, and as to their durability, they lasted so well that at present it was impossible to say how long they might not continue to work satisfactorily. He believed that, at all events, with a little attention, they would be good for six or seven years. The next thing was the question of the burner. At Nottingham there had been a curious question raised, which, perhaps, might provoke a smile. The lamps in that town, which were very large, were all bottomless, there was no glazing, and not even a wire screen. They had continued in this state for 30 years, and as far he could judge were likely to remain so. The company thought as they gave a high quality of gas (about 18 candles at the works, and 16 in the town), that it was very desirable to make the most of that quality; they therefore had all the nibs adjusted with great care upon actual experiment, so that they should develop the largest possible amount of light the gas was capable of affording. They adopted the steatite burner, and had abandoned, or tried to abandon, the narrow slit, so as to give a considerable body of flame, and not expose the gas too suddenly to the oxidizing effect of the atmosphere, but to keep the carbonaceous particles suspended in a state of ignition as long as possible. This, however, gave a sort of limp flame, which did not stand out like a lady's fan. The lamplighters began to complain that the lamps rather smoked, and, indeed, he did not see how it could be otherwise. The company had considerable difficulty with the Lighting Committee on that head, and at last the committee required, as they had the power to do, that all the nibs should be changed, and that narrow slits should be substituted as being in their judgment better than wide slits. The company complied with their requisition, and now there was a loss of about two candles of light in every lamp. So much for the management of the public body. But what he wanted to draw attention to was that the members of the association must not go away with the notion that it was not possible to make the average meter system a perfect success. In many cases it was true it had not been a perfect success; in several it had been a positive failure; but that was chiefly because small meters had been used, because in general they had been dry meters, because those meters had been placed in situations unsuitable for them, and because in some cases an instrument, which had no mechanical properties of any kind—viz., a double tap—had been used in combination with the meter system. He could, however, assure the meeting of this, that if the experience of Nottingham was taken as a starting-point, the average meter system would in every instance be successful.

Mr. DOUGLAS said Portsea was a town in which the average meter system was tried and had failed. The causes of failure undoubtedly were those to which Mr. Hawksley had referred. They had small dry meters fixed to the ladder irons, which were soon found to get out of order. There was no regulation whatever, and there was also determined fraud on the part of the lamplighters. That the average meter system could be made a success, he had not the least doubt. But on putting it to the local board whether the system should be tried under certain conditions, they pointed to the company's Act of Parliament, and demanded their pound of flesh. The Act of Parliament prescribed that if the average meter system were adopted, there should be one meter to every 20 lamps, and no provision whatever was made for regulation. The local board had heard of Sugg's regulator as an instrument which would, under all circumstances, give the quantity of gas to each burner that they stipulated for, and they came to the conclusion that meters were useless. They had accordingly been adopted, and the result had been satisfactory to them. The difficulty the company had was this, that by the contract they only got paid for the gas at the rate of 25 per cent. below the largest private consumer. His opinion was that, for the sake of the public themselves, the public lights ought to pay as much as the private consumers. It seemed to him that those who did not burn gas in their own establishments ought to pay as much for the gas supplied to the street-lamps as those who were compelled to burn it in their shops. He believed that the meter system would yet be adopted in Portsea—not forced upon the company by the local authority, but initiated by themselves as a measure of self-protection.

Mr. HAWKSLEY said he had forgotten to mention that where the average meter system was introduced it was quite immaterial who lighted the lamps. As a general rule, the public body preferred to perform this duty themselves; they liked to have a number of persons about them, and they enjoyed the patronage it afforded. The tables exhibited in connexion with the last paper read related only to the interior of the town of Nottingham, but there was double that number of lamps without the town. Those lamps were under the control of various local boards, who all preferred to manage them after their own fashion. Some of them did not light at all during the summer months or on moonlight nights; some began to light at one period and some at another. To the company this signified nothing; the local boards might do what they pleased; they might change their arrangements quarter by quarter. All the company had to do was to send round an inspector now and then to see that they did not omit to light the metered lamps, and he was bound to say he had never known them do the company an injustice. By this system, therefore, there was an end put to that which had always been an obnoxious question between gas companies and their constituents, which was a matter of no small importance.

Mr. GARNETT said he should not have introduced an observation but for the position in which he happened to stand at Ryde. There had been a good deal said about the advantage of regulators to the public lamps. The town he represented was remarkably hilly; the difference in the levels was something remarkable, and the gas to a great extent was uncontrollable in the mains. Had it not been for the introduction of governors there would have been a considerable loss. For some years the local authority were at war with the gas company simply as to the mode of lighting and the different sizes of the flames throughout the district. Three years ago he had Wright's governors applied to all the public lamps, and they had continued in use ever since, were still as good as new, and from that time to the present they had had uniformity in the shape of flame, and had not received one single complaint from the commissioners as to the size of the flame or anything connected with the burning. He merely mentioned this to show that it was practicable by means of these regulators, especially in hilly districts, to secure uniformity of consumption, to get rid of all complaints such as his company had been troubled with, and he might add at the same time effect a remarkable saving in the unaccounted-for gas.

Mr. HARDICK said Salisbury was one of the first towns to introduce the average meter system, and it had always proved very satisfactory. They used both wet and dry meters, some 2-light and some 3-light; and though they had not indicated with the precision of the Nottingham meters, as exhibited in the table, they had, upon the whole, worked very well. The questions which had forced themselves upon his mind during the discussion, especially on hearing Mr. Hawksley's remarks, was, whether it was absolutely necessary to have a 5-light meter in order to secure accurate measurement, and whether they could not depend upon the dry meter as a perfect instrument.

Mr. HAWKSLEY thought his remarks had been misunderstood by the last speaker. He did not state that they ought to put up only 5-light meters, but that the drum should have the radius of a 5-light meter, in order to get power by giving the pressure of the gas as great a leverage as possible. The necessity arose from the liability of the indices to become clogged, and, in point of fact, bound together by the ammoniacal copper formed either from the water in the meter itself or, as was more probable, from the ammonia in the earth of towns. He had found that the indices in some cases became completely fastened down; and the result was that either the meter had power to break off the gear—which it did in many instances—or would altogether stop, and have to be thrown out of calculation. What really was needed was, a good wet meter with a large radius of drum, and with an index of a very simple kind, very coarse in the teeth, so that the wheels could not be readily bound together.

Mr. MILES could entirely corroborate the remarks of Mr. Hawksley in reference to dry meters, and he gave an instance in which a meter of that description, favourably placed with regard to temperature and freedom from oscillation, which was tested and found correct at the beginning of the lighting season, was 17½ per cent. slow at the close.

Mr. BRADDOCK admitted the value of regulators to the public lamps, but said they had not been tried in the city of York, where, till lately, he had had the management of the works, because the district was very level and the pressure throughout tolerably uniform.

Mr. G. W. STEVENSON said the association were much indebted to Mr. C. Hawksley for his very interesting communication upon a very important

subject. He could not help recalling the time when the average meter clauses were inserted in the Nottingham Gas Bill, and when the President and Mr. Hawksley gave evidence in opposition to their insertion.

Mr. HAWKSLEY said the clauses were in the original bill.

Mr. STEVENSON said he did not desire to argue the subject nor to take exception to the evidence then given, but he believed the JOURNAL OF GAS LIGHTING, of May 3, 1864, would show that he was correct as to the fact. His object in mentioning it was to add that he thought Mr. Hawksley's ability was never shown in a greater degree than in turning a weapon intended to be used against himself against those who were mainly instrumental in forging that weapon. He believed that gas companies and public authorities were much indebted to Mr. Hawksley for having perfected the average meter system at Nottingham, and he was sure it was a system which, if fairly carried out, could not fail to benefit both parties. The regulator, constructed by Mr. Sugg, was an admirable instrument for determining the consumption of gas during the time the burner was lighted, but, of course, it did not regulate the time of lighting and extinguishing, and therefore the meter was required to complete the arrangements, and satisfy the companies and the local authorities that the actual quantity consumed was that which was paid for.

Mr. HAWKSLEY, referring to the observations of the last speaker, said there appeared to be some misapprehension in his mind as to the meter clauses in the Nottingham Act. The company themselves promoted those clauses; they were opposed, and a long conflict ensued, the ground of contention being whether instead of the apparatus proposed by the company the double tap should be used. One of the principal objects with the company in going for their bill was to put an end to local disputes by the introduction of the average meter system. And this reminded him of a somewhat curious thing. The company, acting on the precedents they consulted for the purpose, put into their clause a provision that 1 meter to every 12 lamps should, if required, be used. After the Act of Parliament was brought into operation they did not require it; they were perfectly content with 1 meter to 20 lamps, and they offered that to the Lighting Committee. The latter, however, insisted that there should be 1 in 12, and so it had continued to the present time. And this was very important, because, on reference to the table, which represented only a very small unselected portion of the metered lamps, it would be found that 1 in 120 lamps gave an average which was almost identical with 1 in 12. Therefore he was perfectly justified in saying that, except in small towns, gas managers might be content to adopt 1 meter to every 25 lamps instead of 1 in 12. With regard to naphthaline, he believed that wet meters and the damp ground effectually prevented this deposit and that none would reach the burners. At Nottingham they were not troubled with it, which he attributed to two or three causes—viz., that they did not work long charges and drain off the last products of the coal, for it was from those that naphthaline came; they did not keep their coal in stock for a very long time, for experience showed that old coal produced naphthaline, and above all, they bought the richest coals they could get.

The PRESIDENT said he would not occupy the time of the meeting in expressing at length his own views on this subject, though he had very decided views upon it. He had not the least doubt that a proper system of average meter indication, with governors properly adjusted, was the best means of settling all disputes between the lighting authorities and gas companies. They had had the evidence before them of several gentlemen who had practically tried it on a very large scale; and he only regretted that two or three persons whom he saw present on the previous day were not now in attendance to profit by the discussion. One of those gentlemen he was surprised to hear, in a parliamentary committee this session, state that his company were prepared to resist to the very last the introduction of the average meter system. He (the president) was sure that if that gentleman were now present, and could have heard what was stated in reference to the table exhibited, he would have had all his scruples removed.

Mr. THOMAS RAFFERTY, out-door superintendent of the gas department of the Manchester Corporation Gas-Works, read the following paper:—

ON THE ADVANTAGES OF MECHANICAL APPLIANCES IN RELATION TO THE LAYING AND FIXING OF IRON PIPES FOR THE DISTRIBUTION OF GAS, WATER, ETC.

The distribution of gas, especially in our large towns, is generally acknowledged to form an important part of the duties of a gas engineer. He has frequently to encounter with difficulties, to discharge great responsibilities, whilst endeavouring to perform his duties with credit to himself, satisfaction to his employer or employers, as the case may be, and at the same time to cause as little inconvenience or hindrance as possible to the general public during the progress of the works with which he may be engaged.

It is in hope that I may prove to be of some little service, especially to our young men, who have decided to make gas engineering their profession, that I have, in compliance with the request of the committee, on the present occasion, consented to read a paper "On the Advantages of Mechanical Appliances in relation to the Laying and Fixing of Iron Pipes for the Distribution of Gas, Water, &c."

In order that I may the more effectually show the advantages of the mechanical appliance which I am about to introduce, in laying large mains for gas or water purposes, it is necessary that I should allude in some measure to the mode generally adopted in laying pipes in connexion with gas-works in the United Kingdom.

1. Wide socket-pipes jointed with lead.
2. Wide socket-pipes jointed with iron borings.
3. Turned and bored pipes.

Firstly, with regard to iron pipes jointed with lead, I am fully aware that such are being laid in many of our large towns, not excepting this great city (if I am rightly informed), and that such a mode is strongly recommended and carried into effect by gentlemen who in other respects are eminent in the profession, where engineering skill, talent, and genius are required.

Permit me to say, with all due deference and respect, that I beg to raise my voice, however humble, against the continuance of such a system; and my reason for doing so is because I am persuaded, in the first place, that it is the most costly; and secondly, the most liable to leakage and serious loss of gas. That jointing with lead is the most expensive mode I think it will be readily granted by such an assembly as I have now the honour to address, inasmuch as several articles of material have to be provided, as white yarn, tallow, lead, coals for fire to melt lead; moreover, excavation of earthwork is necessary to make caulking chambers for men to work in while jointing. Almost double the length of paving or flagging, as the case may be, has to be taken up, which may be avoided by about one-half, which I shall immediately show. Disturbing flagging or pavement is a most serious item in the cost of laying mains, and also the removal or carting away of the surplus soil. Does the expense stop there? I say no. In consequence of the sinking of the surface, how often has the corporation or company to repair the surface? Frequently twice, if not more. And why? Because at least one-third of the earthwork is disturbed on which the pipe is laid, taking it to be about the usual length—nine feet.

In the second place, jointing with lead is the most liable to leakage and loss of gas, especially when laid in the carriage-way. Iron and lead are subject to their own peculiar laws of expansion and contraction. Heavy loads or weights passing over materials having no real affinity with each other tend to sever the connexion made, and hence, in after years, when the soil or earthwork is disturbed, or the mains have to be taken up, the lead is found in many instances separated from the iron, and the soil or earthwork blackened and saturated, caused by the loss of gas. This is a state of things I have found in Manchester when taking up mains jointed with lead laid in the carriage-way, after having been in use many years. When such have been laid under the footway and subsequently removed, they have been found in a more favourable position; thus proving the advantage of laying mains under the footways of our large towns. The importance to gas companies to lay their mains in footpaths in place of carriage-ways, which is usually done, might be made the subject of a paper, and I have, therefore, endeavoured to avoid touching upon anything relating to it at the present time.

Secondly, with regard to jointing wide socket-pipes with tarred yarn and iron borings, I have found such, after having been in use from twenty to thirty years—laid in the carriage-way, subject to heavy loads passing over the joints—notwithstanding, the condition of those joints was most satisfactory. And the reason is, I believe, in consequence of the affinity which exists between both bodies. They almost form one substance as to closeness, and are consequently free from leakage. They expand and contract at the same time; hence jointings so made are superior to lead joints.

Thirdly, having had considerable experience in the laying of turned and bored pipes from 2 inches to 18 inches and recently to 30 inches diameter, I must say that I am decidedly in favour of turned and bored pipes being, in my humble opinion, for several reasons preferable to those to which I have referred. 1. The material of the jointing and that of the pipe are one and the same. 2. The joints are quickly made. 3 There is less earthwork to excavate, less to fill in when the pipe is laid, and consequently less to cart or remove away. 4. A reference to the accompanying diagram will show that about half the expense usually incurred in taking up and relaying flagging or pavement, especially in the laying of large mains, is avoided. 5. The pipe has nearly its own length of solid, undisturbed earth to rest upon. These are a few reasons why preference is given to turned and bored pipes. But in the matter of such pipes from 10 inches diameter and upwards, the difficulty and expense attending them has been considerable. The laying of turned and bored pipes of large size, unaided by any mechanical contrivance, has often proved to me as unsightly and as painful a sight as I could see; sometimes two, four, and even more of the strongest men in the section, from Monday morning until Saturday afternoon, bearing and swinging a tup, the weight and size of the tup being in proportion to the diameter or bore of the pipe. But in the laying of pipes 20 inches diameter and upwards of that description of pipe, it could not at all be attempted by manual labour or muscular strength alone.

I am now happy to say, with much satisfaction, that the difficulty which I have had is quite removed by the use of a machine, the make and construction of which has been carried out, under my directions, by my friend, Mr. John Storey, of Manchester. Two different sizes of the machine to which I refer have been in use for some time in connexion with the Manchester Corporation Gas-Works. One is constructed to lay mains from 10 inches bore upwards to 16 inches, and the other is made to lay mains from 18 inches upwards to 40 inches diameter. It was in the act of laying a 30-inch pipe when a photograph of it was taken, and from which I have had it enlarged, in order that all at this our annual meeting might see it, as if at work.

Before I proceed any farther, permit me now to describe its parts and their respective uses.

Drawing No. 1 indicates the machine and the men engaged. The pipe-layer stands at the spigot of the pipe directing his assistants. A, points out the hook on which the tup is suspended; B, eccentric blocks; D, winch for regulating the raising or lowering of the pipe; C, for holding the winch; E, indicates swivel of wheels, so that the machine may move along bends or curves which may happen to be in the route or line in which the main is being laid; F, rings to hold end of chains; G, gauge-rods to direct the wheels when the swivel screw is loose; H, shows the yoke rings so that it may be drawn by men from one place to another, or attached to a cart or lurry; J, scotch to hold the machine fast at any particular point; K, ring for common blocks.

Drawing No. 2 shows the machine having the tup suspended and the man in the position of driving the pipe into its place.

It would be trespassing too much on the time of this meeting were I to give particulars of the saving which may be effected, in every respect, by the use of the machine in laying large mains, especially turned and bored pipes, from the size of 10 inches and upwards. Suffice it at present to give an average estimate of the saving effected in laying a 30-inch diameter, turned and bored pipe.

Particulars of the items dispensed with, and which are required in making a lead joint, are as follows:—

5¼ lbs. of lead, at 2·4d.	£0	10	9
White yarn, 4½ lbs. at 8d.	0	3	0
Making caulking chamber	0	1	9
Melting lead and making joint	0	0	10
Quarter cwt. of coal	0	0	2
Extra soil to be carted away	0	1	1½
Flagging or pavement taken up and relaid, 3 yards at 1s. per yard	0	3	0
Total	£1	0	7½

In the same way an estimate of the saving effected may be arrived at in the jointing of other sized pipes. Hence the reason for giving preference to the laying of pipes having sockets and spigots bored and turned, as indicated by the annexed diagram.

The following are a few instances of the advantages of the mechanical appliances in laying iron pipes which I feel warranted to state after nearly two years trial. I am persuaded that, with the use of the pipe-laying machine, which is quite capable of bearing from one to four tons weight, half the number of men which are employed at the ordinary implements in laying mains would perform more work, and prove more satisfactory in the result. On a recent occasion I observed 14 men laying a water-main,

which was about 12 feet long and 30 inches diameter. Should the sockets and spigots be turned and bored, I would engage to do more work in laying the main with half the number engaged on the occasion (subject to the trench being excavated for the reception of the pipes) with the use of the machine.

As indicated by the drawing illustrating the working of the machine, it moves on rails laid about 6 feet apart, on each side of the trench. The pipes are rolled on cross-planks, and then attached to the eccentric blocks, to be taken to the part of the trench required. Five or six men can roll a pipe, from 18 to 30 inches diameter, lay it in its proper place in the trench, and complete the joint, in the short space of from five to ten minutes.

A wide socket-pipe, of a similar size, with the ordinary implements of a three-legged tool, will take about double the number of men and six times the length of time, before the pipe is laid and its joint completed.

For every four joints of wide socket piping made, say 30 inches diameter, an extra load of overplus soil has to be carted away. And when from 12 to 14 such joints are made, an extra horse and cart has to be hired at from 7s. to 10s. per diem; and, in addition, not unfrequently a charge of from 2d. to 6d. is made for permission to unload the same at a convenient place.

Before I conclude I must say a few words on the importance of a proper understanding existing between the engineer and the contractor. Not only should a specification be drawn as regards the quality of the metal and other matters relating to the pipes, for the information and guidance of the contractor, but he should also be supplied with plans or tracings of the sockets and spigots, and proper gauges, carefully constructed, to correspond with the same, so that the spigots and sockets of all pipes included in the order may be turned and bored accordingly; afterwards carefully tested before taken out of the stores or pipe-yard to be laid where required. The gauge should have three arms or radii, for gauging the circle or bore of the pipe, at points about 120 degrees apart, as shown by the diagram or the models now submitted, thereby securing not only the bore of the pipe to be circular, but the gradient of the turned and bored part of the pipe to be exactly the same. A duplicate set of the gauges should be kept in the stores, belonging to the committee, and placed in charge of a responsible person, who, after having proved the pipes with hydraulic pressure, should, immediately after, prove the correctness of the turning and boring. Careful testing, in some such manner as I have now described, I hold to be, from long experience, most important and also absolutely necessary. Pipes found defective should at once be rejected, for by so doing the corporation or company, ratepayers or shareholders are not only well served, and in after years benefited, but the contractor also; and if he values his reputation and appreciates the connexion he may have formed, he will guard his own interest, avoid errors, and endeavour to give entire satisfaction. Engineers and surveyors who thus act, in the faithful discharge of duty, know from experience the correctness of what I have just stated. I have proved it so.

When we learn, on good authority, that the "capital expended on the gas-works of the United Kingdom is not far short of £30,000,000 sterling, and the sum paid for gas by consumers is not much below £10,000,000 per annum—from 4,000,000 to 5,000,000 tons of coal being carbonized to produce this revenue"—I am persuaded that those who are entrusted with the expenditure of any portion of so immense a sum of money should have, in the faithful discharge of duty, as a watchword, ECONOMY; and that any scheme, plan, or machine introduced by any member of this association, having for its object that end in view, he should not hesitate to submit and make it known, either for the approval or disapproval of the members at their annual meeting.

Mr. GODDARD said some ten or twelve years ago he adopted turned and bored pipes up to 8 inches diameter, and he found that that line of main was the one upon which there was the least amount of leakage in the town. Where mains of this description, of large diameter, were laid, he thought it very desirable to have a receptacle in the socket for melted tallow. One difficulty that had occurred to him in the laying of turned and bored pipes was the rebound in the setting of them up, and sometimes the splitting of the second or third socket from the pipe which was being laid. It was certainly the most expeditious mode of main-laying, and, with care, could be very satisfactorily adopted. They cost a little more in the first instance, but the saving of expense in the laying more than counterbalanced that additional outlay. In using them it might be very necessary to try every pipe by the templet, as they were frequently not perfectly cylindrical when bored. By having the projection of the socket a little beyond the turned and bored part, any leakage which otherwise might arise would be obviated.

Mr. WOODALL said the rebound Mr. Goddard had spoken of could easily be prevented by loosening the earth along the line of pipe.

Mr. CRAVEN said in the district which he represented (Dewsbury) the ground was undermined by collieries, and, where the earth was liable to sink, he found the lead joints stood best, and that he had the greatest amount of leakage with turned and bored joints.

Mr. MILES said he came from a coal district (Tyldesley), and, having turned and bored joints in use, he experienced all the difficulty spoken about by the last speaker from the sinking of the earth. He should like Mr. Rafferty to tell the meeting whether he laid turned and bored joints round sharp curves in Manchester; also whether there was not a liability of the earth falling in around his machine.

Mr. RAFFERTY, replying to the last question, said he took care to be always well prepared for any accident of that kind, by having plenty of timber cut to various lengths, so that the instant there was the least indication of the soil giving way they were able to shore it up. With reference to sharp curves, of course pipes laid at right angles could not be used with turned and bored joints, but it was astonishing to what an extent of curve such joints could be applied. He had ascertained that contractors could manage irregular pipes as well as regular pipes, so that recently he had got them to turn and bore branches and bends. It required care and judgment in measurement so as to get accurate gauge, and, where turned and bored irregular pipes would not suit, he was obliged to carry out the old system.

Mr. OHREN asked whether Mr. Rafferty had had any experience of turned and bored pipes in clay. His own experience in a clay soil was, that the traffic in the streets above caused the mains to rise, and he had had them come right out of the ground from a depth of two feet. The other description of pipes rose to a certain extent, but they seemed to get wedged by the lead joint. No doubt size had something to do with it, and probably pipes of large diameter, properly laid, would keep their position very well; but he thought it should be a consideration with engineers, when determining upon the use of turned and bored joints, what was the character of the soil in which it was proposed to place them.

Mr. C. WOODALL said in Stockton they had nothing but clay soil, and they had nothing but turned and bored joints, from 2 to 15 inches, still he never had experienced the trouble to which Mr. Ohren referred. Probably if Mr. Ohren had had the ordering and laying of the mains himself there would have been no such difficulty. It was because this class of mains was sometimes so badly laid that a prejudice had been excited against them; and he felt sure that, if fairly tried, under almost all circumstances they would give satisfaction. At Burslem, in the Potteries, where the district was considerably undermined, they sometimes had broken pipes; but they preferred to have a pipe broken right through, as was invariably the case when an accident happened to a turned and bored pipe, than to have the joint drawn out, as was the case when lead joints were employed. He wished to know what was the matter which was exactly covered by Mr. Rafferty's patent, as he felt rather nervous about it. He had himself used an ordinary three-legs, and he remembered to have seen an apparatus, identical with that shown in the drawings, in use three years ago.

Mr. OHREN asked whether the pipes Mr. Woodall referred to were laid in the foot or carriage ways.

Mr C. WOODALL: In the carriage-ways.

Mr. BROADHEAD said at Grimsby he had used turned and bored joints for sixteen years, and he had no fault to find with them. In one part of the town the soil was clay, in the other it was sand. He used no lead joints and no tallow, and his per centage of leakage, including stealage and waste, was only 11 per cent.

The PRESIDENT said there could be no doubt that engineers must be influenced a great deal by the nature of the soil with which they had to deal when deciding upon the use of any particular description of pipe. He had himself tried the experiment of laying turned and bored pipes in soft peaty soil, and he soon had to take them up. In gravel or strong clay, or good firm rock, turned and bored joints could be very advantageously used, but there were circumstances in which lead-jointed pipes were better employed.

Mr. RAFFERTY, replying to Mr. Woodall, said he had never seen any similar apparatus to that which he had exhibited. He had found it extremely valuable in use, particularly in taking up pipes requiring to be raised from the ground without inconvenience to the public.

The HONORARY SECRETARY read the following paper:—

ON AN IMPROVED ARRANGEMENT OF A PURIFYING-HOUSE AND APPARATUS,

By Mr. WILLIAM ESSON, of Cheltenham.

The house is 85½ feet long by 64½ feet broad at one end, and 89½ feet broad at the other end. The extreme height, from the basement floor to the square of the walls, is 42 feet. The irregular horizontal section of the house was adopted to fill up the ground. The triangular portion being on one side, comes in very fitly for containing the steam-boiler and engine, hoisting apparatus, and iron stairs, without encroaching on the parallelogram allotted to the purifiers and purifying materials. The elevation is divided into basement, ground, and first floors, being in that order each respectively in clear height 9 feet, 12¾ feet, and 14 feet to the square of the walls. The pillars, main and transome girders for the first floor, and the girders and gratings of the ground floor are of iron. The roof is of iron, and tiled. The house is lighted from the roof and side walls.

The window-frames and sills are of iron, and each window has a ventilator. The windows are glazed with obscure furrowed glass, admitting light but not vision. The main roof covers a parallelogram, hipped at both ends, carried on the walls on *three* sides, and on a gutter girder supported on cast-iron pillars on the *fourth* side. These pillars, six in number, in conjunction with the 24 pillars for carrying the purifiers, *also* carry the iron girders of the two floors. The small roof, triangular in form, on *one* side rests on the gutter girder, and on the *other* sides on the walls. The iron girders and their transomes extend from wall to wall, and are fastened with strap-bolts, wall-plates, and nuts, and thus impart great stability to the entire structure. Strong iron bond was put in under the first-floor girders, set in cement. The set-off and the courses in the walls above and below it were set in cement. Iron bond was put in the springing courses for the arches of the upper windows, and *across* the windows, with a camber under their arches.

Above the *window* arches iron *bond* was built in, and *these*—the bond last mentioned, the arches, and the walls from the springing courses of the arches to the top—were all set in best quality of cement. The walls to the first floor are 18 inches thick, thence to the top 14 inches. No sensible vibration, either before or since the roof was put on, during the greatest gales, has been felt.

There are six purifiers, in two rows of three to each row, and are in two divisions, one division of four with a centre-valve, worked three in and one out of action, and one division of two worked with a centre-valve, one in and one out of action. These last two are called the finishing purifiers. They are all 4½ feet in interior depth, by 20 feet square in the clear. There is provision for five tiers of gratings in each, but only two are generally used.

The connecting-mains are 14-inch bore, and all the gas passages of irregular form of section have an area of 200 inches. Each purifier is set on four iron girders, forming a square of 14 feet on the side, carried on four pillars all connected and tied to the walls as before described. The floor surrounding the purifiers is carried on framed and trussed girders, resting on the girders connecting those which carry the purifiers, and are of a depth sufficient to place the floor exactly on a level with the top sides of the purifiers. Alongside the purifiers, and resting on the connecting girders, and under the floor, is a water cistern, 82 feet long, 4 feet by 5 feet in section, for storing the roof water for the use of the steam-boilers. On the floor the rails are placed for working the travelling cranes, by which the purifier-covers are lifted and transported over an adjoining purifier. Near the centre of each purifier is a 2 feet on the side square funnel, extending from the bottom to about 18 inches below the top, with a moveable door having cross-bars and set screws for fastening it down. These funnel doors when closed are luted with sealing materials the same as those used for the retort-lids. The basement and ground floors are used for the storing and revivifying of the purifying materials. When ready for the purifiers these are taken up by a hoist from the basement to the purifying or first floor. For this elevating process there are provided a steam-boiler and engine, and two hoisting cages. The steam-engine has two cylinders, with a link motion, and friction pulley, strap, and lever by which it is wrought. Suitable two-wheeled barrows are employed for getting up the material. They are filled below, run on to the hoisting cage, carried up to the purifying floor, run over a purifier on a suitable and moveable roadway resting on it, and the contents discharged therein. The barrow is sent down again by the return hoisting cage, and the process continued until a purifier has been filled. Six barrows are in use during the operation of filling. One purifier can be filled in about an hour. In working the first four purifiers there are always three in and one out of action. When the test shows impurity in the gas at the middle purifier the set is "turned over," so that the gas has always one purifier in the first set clean. Lime is used in the bottom shelves of each of these first set, and they are filled up with iron.

The lime in each of the bottom shelves of the first division is not so often

removed as the iron; it occasionally gets caked and hardened, and is then broken up, and allowed to remain until it has become spent. It will continue its purifying energy for four or five times as long as one turn of the iron, under the usual conditions. The gas in its progress onwards from the breaking purifiers comes in contact first with the lime, and then with the iron, and is thus consequently admitted at the bottom of each of the purifiers, and discharged at the top in the first division. In the second division of two purifiers the gaseous current is reversed, being admitted at the top and discharged at the bottom. These purifiers are filled wholly with iron. The iron on being removed from them is used for one turn in a purifier of the *first* division before it is again used in one of the *second* division. This arrangement and plan of operation have been found very satisfactory, and ensure a comparatively pure gas, the sulphur compounds being about 10 grains, on an average, to 100 cubic feet of gas. Although opposed to the opinions and practice of many in every way entitled to respect, they have not been adopted without careful comparative trial with other methods known to the writer. It may, perhaps, be here mentioned that in connexion with this arrangement there are two breaking purifiers of considerable capacity, and which are wrought alternately. These are charged with iron that has become nearly spent in the other purifiers; they are not turned over when the gas passing through them shows foul, but generally when the caking of the contained iron causes too much pressure. By the use of these, two ends are gained—a thorough exhaustion of the purifying qualities of the iron, and an interception of the portion of the gaseous volume which generally soaks with a tarry-looking substance the purifying materials on the first shelves of the purifiers, and prematurely impairs its purifying energy. It may also be conjectured that the iron so treated will contain a higher per centage of sulphur and ammonia, and thus become a higher priced marketable commodity.

The ground floor is formed of moveable iron gratings resting on iron girders. When the iron has to be changed in any one of the six purifiers, the spent charge is thrown down on the iron gratings of the ground floor through the before-mentioned funnels in the interior of the purifiers. It is spread out on the gratings at a depth of about 30 inches, and the mass becomes thoroughly revived in about a week, and is again ready for use; whereas, if laid on a close floor, it would at that depth take about double that time, and require at least two turnings over. The iron having revived, and again become fit for being put into a purifier, an opening is made in the centre of the mass, and one of the gratings removed, thus forming an opening in the floor. Through that opening the material is tipped down into the barrows (on the basement floor), and is taken up by the hoist, wheeled over a purifier on the first floor, and the contents therein deposited. In like manner in succession for all the purifiers, and with all the iron.

Mr. SHARP asked the description of valve employed.

Mr. ESSON: Cockey's valves.

Mr. LONGWORTH asked the size of the purifiers.

Mr. ESSON: Twenty feet square.

Mr. LONGWORTH asked the cost of the whole building complete.

Mr. ANDERSON said he was about to ask a similar question. It appeared to him that this was a very expensive mode of constructing apparatus. In the first place, he did not know for what particular reason it was necessary to have a house all round the purifiers. Certainly, if there were any fumes from the purifiers, it was better to let them get out, and unless there was plenty of ventilation the health of the men would suffer. It appeared to him that the most economical way to place purifiers was to partly sink them in the ground, because the pipes coming to the purifiers were usually underground, and there was greater facility for cleaning and filling and discharging. He found it very convenient to have purifiers about 2 feet 6 inches underground, and as much above ground. A man could then very well empty the stuff into barrows or waggons for the purpose of its being carried away to be revivified, and a great amount of expense in construction was saved. He did not see any other objection to the drawings, except that the mode of construction they illustrated was more expensive than need be. The continuous wear and tear was a matter which would more than compensate for any advantage in having purifiers so placed. With regard to the lime and oxide, he should like to ask a question. He understood that the bottom tray was lime and the upper tray iron, and that the lime lasted four times as long as the iron. Did Mr. Esson refer to the power of the lime to take out carbonic acid during the whole time the other three charges of iron had been in practice? If so, he could only say he did not find the same results in the works with which he had to do. Referring to the plans, he supposed that Mr. Esson was to some extent cramped for space, or he would not have put his engine into the purifying-house, for, as a practical man, he must know that the fumes from the purifiers were not good for engines.

Mr. GARNETT said, having recently constructed at Ryde a purifying-house very much in the fashion of that described by Mr. Esson, he might be permitted to say a word or two. His purifiers were 12 feet square, and 4 feet 6 inches deep, and were placed in a similar manner, but he had no second flooring. The bottom of the purifiers was about 10 feet from the ground floor. With regard to the working of these purifiers, he might say that up to the present time he had found no inconvenience, and he thought in cases where it was desirable to do the thing very nicely, as in a place like Ryde, some arrangement of this kind would have to be adopted. The total cost had been about £1375.

Mr. GODDARD described the arrangements of his purifying-house, which appeared to be very similar to those adopted by Mr. Garnett, except that the purifiers were 20 feet square instead of 12.

Mr. ESSON said the cost of building his purifying-house and apparatus, in which there were six purifiers, each 20 feet square in the clear, was, in proportion to the difference of size, &c., less than that mentioned by Mr. Garnett. With reference to the fumes, he was glad to say they were *non est*, so far as the workmen were concerned. The roof of the house was purposely tiled for ventilation, and there was also 6 inches opening for ventilation all round the roof windows. Although the purifying-house was close to other houses, yet, owing to the height and mode of construction, no complaints were ever made. If the purifiers had been on the ground, the probability was there would have been complaints from the workmen and neighbours. The purifying-house was not enclosed in the sense Mr. Anderson seemed to think. One side wall was built so as to admit of another house being erected at that side, and there were large openings for communication between the two. It might in some cases be desirable to have the pipes underground, but in other works it might be equally desirable they should be above ground, for the sake of easy access thereto. In other purifying-houses he had the pipes underground, but he had thought it right to excavate the earth all round, so as to be able easily to keep the gas passages clear. With respect to the cost of purification per 1000 cubic feet, it was about the same as that of his neighbours. What he meant to say respecting the lime was that, until he found it spent, he did not remove it. The steam-engine had not been injured by the fumes from the purifiers. It was generally covered over, when not at work, with a canvas cover; and, though placed in the purifying-house, it had not suffered at all. The house had not been altogether built for the purpose of enclosing purifiers; it was a revivifying-house, and a store-house for the material.

Mr. CATHELS then proposed that the best thanks of the association be presented to the writers of the several papers submitted for discussion.

Mr. LONGWORTH seconded the motion, and, referring to the second paper read during the present meeting, suggested the propriety of the committee of the association taking some means to ascertain the best mode of scurfing retorts.

Mr. WOOD thought it would be better for Mr. Longworth to try some experiments himself. Sufficient had been said to induce all the members to determine upon making some trials.

The PRESIDENT said the view of the committee was that they ought not to endorse any particular scheme, but to lay the various subjects before the association, with the object of enabling the members generally to form a judgment upon them.

The motion was put, and carried unanimously.

Mr. GODDARD said the committee had been applied to by gentlemen who were desirous to compound for their annual subscriptions by the payment of a single sum, and the committee felt it right to bring the matter before the association for their opinion. He moved the following addition to the rule—"Any member may compound for his annual subscription by the payment in one sum of ten guineas. All such compositions shall be invested in the names of three trustees, and the interest alone shall be appropriated to the current expenditure of the association, except by special direction of the committee."

Mr. ESSON seconded the motion. He said the practice was common in most of the institutions of the day, with very considerable advantage to the members individually and convenience to the general body.

Mr. BROADHEAD rather objected to this constitution of life members by a single payment, because in the case of future misconduct it would be impossible for the association to get rid of an offender.

The PRESIDENT said the provision was only a permissive one. As to expulsion from membership, the association had no such power under the present rules, and a person misconducting himself could only be made amenable to public opinion.

The motion was then put and carried.

The PRESIDENT then announced the result of the ballot. Eighty balloting-papers had been received, and the results were as follows:—

For *President*, Mr. Goddard; *Vice-President*, Mr. Esson.
For *Treasurer*, Mr. Newall.
For *Committee* (to replace the three members going off by rotation), Mr. Loam, Mr. Arnott, and Mr. Thornton Andrews.
Hon. Secretary, Mr. J. Blackburn.
Auditors, Mr. Leather and Mr. Newbigging.

Mr. NEWBIGGING proposed—"That the best thanks of the association be presented to the council of the Society of Arts for their kindness in allowing the use of their rooms for the present meetings; and also that the best thanks of the association be given to P. Le Neve Foster, Esq., M.A., secretary of the society, for his courtesy and attention during the sittings." He had attended every meeting of the association since its establishment, and he thought he might say without fear of contradiction that this was the pleasuntest room they had ever been fortunate in obtaining. As a correspondent of Mr. Foster's for the last eight years, he could bear testimony to the desire of that gentleman on all occasions to do everything in his power to further the interests of science and art.

Mr. OHREN seconded the motion.

The PRESIDENT, in submitting it to the meeting, said he was sure that no words of his were necessary to enlist the sympathy of the members in its support, and therefore he would at once put it to the vote.

The resolution was most cordially adopted.

The PRESIDENT said the next business was to decide upon the place and time for holding the next meeting. The committee had had several towns under consideration, but they had not instructed him to mention any one in particular.

Mr. BROADHEAD proposed that the next place of meeting be Leeds, and the time Whitsun week, 1869. He had proposed Leeds for the fourth time, and he hoped he should now be successful. His motive, in the first place, was that he felt it would be a tribute of respect to their late friend, Mr. Adamson; second, that Leeds was a provincial town second in manufacturing importance to none other in the kingdom; and third, because it was his native place.

Mr. CRAVEN seconded the proposition, and commended its adoption, because of the facility of communication between Leeds and most parts of the country.

Mr. LONGWORTH proposed, and Mr. MILES seconded, a motion to the effect that the place of meeting be the town of Liverpool.

Mr. DOUGLAS proposed, and Mr. IRONS seconded, that Cheltenham be the place of meeting.

On a show of hands, the town of Liverpool was decided upon by a large majority, and, after some conversation, the time of meeting was fixed for the first Tuesday in June, 1869.

Mr. C. HAWKSLEY said it devolved on him to propose a vote of thanks to the committee for the very great pains they had taken in transacting the business of the association during the past year. He wished the duty had fallen into abler hands, but no one, he was sure, could submit it with greater cordiality to the meeting.

Mr. BRADDOCK seconded the motion, which was put, and carried unanimously.

The HONORARY SECRETARY: On behalf of the committee, permit me to express their thanks for this mark of your approval. It is a great pleasure to the committee to be of service to the association, and I can assure you they have devoted a great deal of time and labour to the business which has come before them.

Mr. SHARP: I rise, Mr. President, with great pleasure to propose a vote of thanks to our respected friend, Mr. Blackburn, the honorary secretary of the association. We all know that in any society an efficient secretary is the most valuable officer they can possess, and we can all bear testimony to the zeal and ability which Mr. Blackburn has brought to the performance of his duties. I have had to correspond with him, and have always received the greatest amount of attention and courtesy from him.

Mr. SLIP: I have very great pleasure in seconding the motion.

Mr. BROADHEAD supported the motion, and said the many complimentary remarks which were found upon the voting-papers showed the respect in which Mr. Blackburn was held by the members of the association.

The PRESIDENT: I have no doubt that what has been said with reference to Mr. Blackburn will be endorsed by every one connected with the association. I shall only speak for myself. I have had frequent occasions to cor-

respond with him, and greatly admire the order and regularity with which his proceedings are conducted. No one more appreciates his services than I do.

The resolution was put, and carried amidst loud cheers.

The HONORARY SECRETARY: Mr. President and Gentlemen, I can only say that I thank you most heartily and most sincerely for the manner in which you have been pleased to mark your approval of my services. It is a great pleasure to me to have been of use to the association, and I can assure you that so long as my other engagements will permit me to discharge the duties of honorary secretary, my services will be at your disposal.

The PRESIDENT said that concluded the business of the meeting.

The HONORARY SECRETARY moved—"That the most cordial thanks of the association be given to Mr. Barlow for the great interest which he has at all times taken in the prosperity of this association, and for his great and marked attention to the duties of the office of president during the past year; also for the excellent address with which he inaugurated the present meeting, and for the urbanity he has displayed in presiding over the business of the last two days."

Mr. STEVENSON, of Dublin, seconded the motion, which was put, and carried by acclamation.

The PRESIDENT, in acknowledging the vote, said he felt almost overpowered with the flattering manner in which his name had been received. He could only say that from the first he had felt an interest in the association, and had done his best to promote its success. He had been much pleased in presiding over these meetings, and would promise that, for the future, whenever opportunity was afforded him, he would do all in his power to further the interests of the association.

Mr. PARKINSON said there had been an unusual number of visitors present at these meetings, and, as one of those visitors, he ventured on their behalf to thank the president and council for their kindness, and to express the pleasure it had afforded them to attend and listen to the very interesting proceedings of the association.

In the evening about eighty of the members and their friends dined together at the Freemasons Tavern.

THURSDAY, JUNE 4.

This day a party of about 80 members, under the guidance of Mr. George Anderson, met by appointment at the Hungerford Pier, at 10 A.M., and proceeded by steamer to Woolwich on a visit to the Royal Arsenal. The members were met at the gate by Mr. Wallace, superintendent of the gas department, who very courteously conducted the party round the various departments of the gun and ammunition factories, where the members had an opportunity of witnessing the forging of the Armstrong guns, and the entire process of manufacture. The gas-works and the stores department were also visited, and much gratification was expressed at the pleasant manner in which the day had been passed. On the departure of the party, at about 5 P.M., a hearty vote of thanks was accorded to Mr. Wallace for his attention.

Other members of the association formed themselves into parties, and visited a number of the metropolitan gas-works and other places of interest.

Parliamentary Intelligence.

HOUSE OF COMMONS.

(*Before Sir* H. RAWLINSON, *Chairman; Mr.* WALROND, *the Hon. Mr.* PORTMAN, *and Mr.* BRUEN; *and Mr.* BONHAM-CARTER, *Referee.*)

DUNDEE GAS BILLS.

(*Continued from page* 427.)

MONDAY, MAY 25.

Provost *Hay* recalled, and cross-examined by Mr. POPE.

The bill, as altered, was submitted to the people of Dundee on the 11th of March. The alterations were agreed to by the council in February, and published in the newspapers on the 6th of February. The power to the arbiter to decide whether the agreement was a voluntary or a compulsory one was agreed to be inserted in the bill on the 4th of February, and the fact was published next day. The clauses were drawn up by the council as their understanding of the agreement. We sent then to the gas companies, and they objected to them as not according to the agreement. We then met in several conferences, with the view of settling these difficulties. In the course of these conferences we agreed on all the clauses except two. One was the clause changing the date of the transfer of the works. They wanted the transfer postponed for six months, and that we would not consent to. The other clause related to the terms of the transfer, and in what way we should deal with the letter granted at the request of Lord Stradbroke's committee, declaring that the alterations on last year's bills should not prejudice us in the price. We disputed about that, and went to the referee, and Mr. Lloyd said, "I will schedule the agreement, and it will speak for itself."

In answer to a question from Mr. BONHAM-CARTER,

Witness said the companies wished a postponement of the transfer, but Mr. Lloyd said they must stand by the agreement.

Cross-examination continued: One of the matters adjusted on the 11th of March by Mr. Lloyd was clause 25a—that "the commissioners shall make payment of annuities on the share capital of the companies as at the 11th of November 1868." That was not in the agreement, which Mr. Lloyd ruled should mark the date of entry. I have a general recollection of what the provisions of our bill were when it was submitted to the public of Dundee.

Mr. POPE: Well, let me ask you this—Was the original provision with reference to the price, in clause 23 of the bill, simply that the council should pay a price corresponding to the "fair value of the works?"

Witness: "Shall pay annuities corresponding to the value thereof."

Mr. POPE: Is that what was in the bill when it went to Mr. Lloyd?

Witness: It went to Mr. Lloyd with this clause in it as regards the old company, but not the new. The new company came to terms, and we proposed the same to the old, but they did not agree, and stood out upon this—First, the dealing with the letter of Lord Stradbroke; and, secondly, the date of entry into the works. We split upon these two points, and we were obliged to come to London to adjust the bill before Mr. Lloyd. He said that, having agreed with the new company, the old company must get the same terms. That is the state of the matter. The clause we have substituted for the original 23rd clause (which was objected to by the companies) is in the terms of the agreement.

Mr. POPE: What was the amount of the share capital of the old company at the date you made the agreement last year?

Witness: I could not go into the question of share capital. There are gas directors here who can give you information.

Mr. CLERK: We have a statement of the capital. [Statement handed in.]

Mr. POPE: Let us see if it contains the information we want. Was the amount of the capital of the old company, when you made the agreement, £29,706 18s. 1d.?

Witness: I understand so; but I do not know personally.

Mr. POPE: Did you not ascertain in any way the financial condition of the companies that you were to buy up?

Witness: I left that to arbitration.

Mr. POPE: But you know you have agreed now not to pay annuities upon the "fair value" of their property, but upon their share capital as at the 11th of November, 1868.

Witness: That is in the agreement, only we are to pay them by annuities instead of a capital sum corresponding to the price of the works. If there is £50,000 or £100,000 capital stock, that matters nothing to us. We simply pay the value of the undertaking. And, instead of paying a capital sum, we are to pay in annuities, as provided by the agreement, a dividend corresponding to the value of the works, divided among the shareholders.

The CHAIRMAN: A dividend, but at what per centage?

Witness: A dividend to be fixed by arbitration upon the value of the works.

Mr. POPE: That clause says nothing about the value of the works. It says, "upon the share capital."

Witness: But read the second clause of the agreement.

Mr. POPE: I am not talking of the agreement. Here is a clause you ask the committee to enact. Never mind the agreement. Tell me what the effect of the clause would be.

Witness: The payment upon the share capital is simply the dividends which might accrue upon them, and is the consideration for the undertaking.

Mr. POPE: Now tell me, as a lawyer, what is the difference between the two clauses?

Witness: I do not see any.

Mr. POPE: Let us see really what you mean. Did you know what the amount of the capital was at the time the agreement was made? It was £29,706—is not that so?

Witness: There was £50,000 of debt.

Mr. POPE: Quite so—£50,000. What does it cost to raise money in Dundee upon such security as the gas companies can offer?

Witness: Five per cent. at least, I think, on the average.

Mr. POPE: Well, we will assume it at 5 per cent., and we will see what the result of the calculation is. As the clause originally stood you would have paid annuities on £29,706 18s. 1d.; and the debt could have been paid off by borrowing money at 5 per cent.

Witness: Well, I will suppose so.

Mr. POPE: Well, has not that £50,000, since the date of the agreement, been converted into stock, so as to come into capital at November, 1868?

Witness: I understand the debt has been paid off.

Mr. POPE: Then the effect will be that, instead of annuities upon £29,000 odd, and paying off the debt with money borrowed at 5 per cent., that clause will saddle the community with annuities upon £79,000.

Witness: I do not think so. That does not at all follow. They only get the price of their works. We could not have raised the money to pay that price by a capital sum, so we arranged that it should be paid by annual dividends, or you may call them annuities, calculated on the value of the works. I purposely avoided entering into that part of the agreement, because we had no means of testing the real value of the works in all their bearings. It is for skilled persons to say what amount of dividends they should get from us, and that will be fixed by the arbiter.

Mr. POPE: Then the effect of what you have done by the insertion of this clause is, that whereas at the time of the agreement you could have got the concern by paying annuities upon £29,000 odd, and paying off £50,000 of debt on such terms as you could have raised money upon, now you will have to pay annuities in proportion to dividends upon £79,000?

Witness: Most certainly not. They will get the price of the works. Suppose that price to be £100,000, and suppose there were 50 shareholders last year, and 100 this. The dividend will be calculated, having respect to the value of the undertaking, and a slump annual value fixed, which sum will fall to be divided among the shareholders. If there is a larger basis of capital and shareholders on which the price must be divided, then each annuitant will get a less per centage or dividend than if there were a smaller number. But the purchaser has no concern with this.

Mr. BONHAM-CARTER: Is this £50,000 stock or debt?

Mr. POPE: It is stock now, but at the date of the agreement it was not.

Mr. BONHAM-CARTER: Then it will take the form of annuities?

Mr. POPE (to witness): It has been converted since the agreement into stock, the maximum dividend on which is 7 per cent.?

Witness: I have heard so; but that, in my opinion, has nothing to do with the purchase-price, which is the value of the works.

The CHAIRMAN: But a maximum dividend of 7 per cent. may involve a minimum dividend of much less.

Mr. DAVISON: Just so. We hold that whoever values the works will value them as a going concern, and as producing annually a certain sum.

Cross-examination continued: I did not say on Friday that I complained of the illuminating power of the gas having got worse. I said that such was the general complaint. I, of course, share in the general belief. I do not know what the illuminating power of the gas was prior to 1866, although there were various statements made and published. I have noticed a slight diminution in the illuminating power since last year, and the price has been raised, I believe, 2d. per 1000 feet. I cannot speak much as to the illuminating power. I do not know that in Edinburgh the price has been raised 6d. per 1000 feet, and in Glasgow 5d.

Mr. POPE: Are you aware that Perth has risen 2s. 6d. per 1000 feet during the year—though that is surely a mistake?

Witness: Oh! no; it is no mistake; and I am glad you mentioned it. It only shows the great necessity for this bill. There was a competition in Perth between the old and new companies; but that competition has been destroyed—one of the companies ruining the other—and the inhabitants are now paying over 6s. per 1000 feet for their gas.

Mr. POPE: Just so. As long as there was competition the gas was 4s. 2d., but when they joined the price went up to 6s. 8d.

Witness: It is always so. Competition goes on for a time, till the companies join, and the public are the sufferers. The only remedy is to take it into their own hands. I was not aware the price had risen 10d. in Montrose, another of the seven towns.

Mr. POPE: You complain of the price, and yet have not taken the trouble to see what the prices of the other towns were.

Witness: I have received great complaints of bad quality, and large additions to the gas accounts.

Mr. POPE: And did you not take any action in these complaints?

Witness: Yes; we tested the gas, and got different reports—some said it was as low as 17 or 18 candles—but the companies denied the correctness of our reports. This has impressed the public still more strongly with the idea of the necessity of having some more security for good and cheap gas, and that can only be afforded by their getting the gas supply in their own hands. As chief magistrate I have taken an active part in promoting the scheme, but I have no personal interest in it except as one of the consumers. I remember stating, at the public meeting held on the 31st of October, 1867, that I believed a transfer of the gas-works would relieve the community of one-half of the assessment they pay at present. We had many complaints at the Police Board as to some assessments, but I saw these were trifling things compared with the price of gas; and what I meant was that I believed, if this transfer were effected, it would be followed by a reduction of our gas accounts equal to one-half of the police-rates. That would result from having the gas cheaper and better.

Mr. POPE: Cheaper and better! The cheapness of the gas will depend very much upon the price of the gas-works, will it not? And the amount of capital employed would regulate the cost of production—at all events, it would have something to do with it?

Witness: I have said to you that I have left that as a matter for a skilled arbitrator. We will give a fair price for the works, and so will be able to give cheap gas. The price of the works is simply the value of the undertaking.

The CHAIRMAN: I should like to know how the arbiter is to obtain the estimate of the value. The produce depends upon the price.

Witness: Yes; but I think the price will be a fair price, according to the value of the undertaking.

The CHAIRMAN: But the value of the works depends upon the price.

Witness: Quite so; and therefore I leave that to the arbiter to fix a fair price under the circumstances.

Cross-examination continued: When I said I believed the transfer of the gas-works to the community would save half the assessment, I meant the police-rates, which are 1s. 2d. in the pound; and I think they would save the half of that still.

Mr. POPE: Would that amount to £10,000 a year on the heritable value of the property in Dundee? What is the heritable value?

Witness: About £330,000. But that is not the way I look at it. Suppose a working man with £5 rent, and that he pays 7s. of police-rates, I believe he would save the half of that on his gas account if the gas were in the hands of the corporation or a commission.

Mr. POPE: Now, what is the total gross revenue of the gas companies? I want to see how this question has been considered.

Witness: I do not know.

Mr. POPE: You do not know! This is the first time I ever knew of a Scotchman making a bargain and not know what he was buying.

Witness: I told you I left that to the skilled arbitrator to fix the price.

Cross-examination continued: As to bill No. 2, we lodged that, having some doubts about a portion of the shareholders of the old gas company agreeing to the bill, and having power—under what is called the Wharncliffe meeting—to veto the bill. Therefore bill No. 2 was lodged, so that, if such a thing took place, the council might resort to it, and acquire the new gas company's works. But if this present bill be carried, and all parties are sincerely endeavouring to carry out the agreement, there will be no occasion for No. 2. It is provided in the new gas company's Act that we may take over their works, but I don't think that gives us the power, and I think this bill is the best for the community.

Mr. POPE: But you have sufficient power to take the new company.

Witness: No; I don't think we have. But we are now in a position to take both according to the agreement, and I stand here for the agreement in its integrity.

Re-examined by Mr. CLERK: There are numbers of the Chamber of Commerce who are directors of the gas companies, and who are opposing this bill. A number of these gentlemen are in the room. Mr. Cox's brother is a director. Last year it was arranged that the amalgamation bill should be withdrawn, and that each company should have power to seek additional capital. That was known to everybody in Dundee. It was part of the arrangement that each company should go to Parliament to increase their capital, and that we should go and obtain powers to buy the works. We were declared joint promoters in the bills before the committee, and these money bills would just become our property next year. This agreement was almost universally approved of last year. The old company obtained power to increase their capital by £50,000 to extinguish their mortgage debt. We thought it much better to have the works clear of debt before we took them. The whole works are to be handed over, and will be valued at the date of purchase by some competent person, and in order to get at that value the arbiter will look to the balance-sheets of the company as at that date, and will take into account the selling price of the gas, the secondary products, profit, &c. If the sum had been capitalized, that would have been a matter of so many years purchase; but, in lieu of that, we are to pay annuities upon the value which may be ascertained rather than pay a slump sum down.

Mr. CLERK: My learned friend has appealed to you as a Scotchman; but I appeal to you as a man of business, and I ask you, do you ever find parties agree upon a question like this unless they are compelled?

Witness: No; we generally find we have to pay large sums unless we have the power to demand arbitration.

Mr. CLERK: Have you any idea that the companies would sell you their works just now at any such price as an arbiter would fix?

Witness: No; we were entirely at their mercy last year; but if this Act should pass, giving us the power of arbitration, we will be on equal terms, and will be prepared to give them a fair price, and to demand arbitration.

Mr. *A. J. Warden*, examined by Mr. DAVISON.

I am a merchant at Dundee, and convener of the Nine Trades. There was a general meeting called of the trades on the 20th of November, 1867, to consider the gas question, and resolutions were passed in favour of the gas bill. A committee was appointed to aid the council in carrying the bill, and I am here representing the Nine Trades. I have been about 35 years in business in Dundee, and am manager of the Dundee Calendering Company. I am a pretty large gas consumer. I agree with the provost that practically there has not been competition between the gas companies for some time. It is my opinion that it would be a good thing if the works were transferred, and the trades have the same belief. I also believe that if this be the case the consumers will get a better article at a cheaper rate. I think also the consumers will have a check upon the commissioners which they have not upon the companies. The Harbour Board, of which I am a member, is elected by the various bodies exactly as proposed in this bill. It has hitherto wrought well for Dundee, and has the largest interests confided to it of any board in the district—and it has no interest either in profit or loss—while the commissioners would have to provide the gas economically.

Mr. DAVISON: And you think they would require some security for the annuities?

Witness: I do. I do not think they could borrow the money at a low rate of interest without some such security. They would not get the money to borrow without some tangible security to give.

Mr. DAVISON: And with some such security as that they would be able to raise the money on advantageous terms?

Witness: Yes, on the very best of terms, because the security is absolute. The Harbour Board have now a sinking-fund which enables them to borrow on the best terms.

Cross-examined by Mr. RICHARDS: I was deputed to come here and support the bill. The general feeling in Dundee is that the gas is below the average of the seven towns. I am not aware, however, that the Town Council have taken any steps to impose the penalties. The clause in the new company's Act, giving the council power to purchase their works, no doubt exercises a moral force on the old company. I know that both companies have been working under an agreement for some years, which destroys competition. The Nine Trades have had the bills before them, and they are satisfied, for they sent me to represent their opinions here. They have seen the notices of alterations in the newspapers. I have read notices of the altered bill in the newspapers. It is perhaps two or three months ago since I saw the bill in its present state. I have had no meeting of the trades to discuss the alterations. None of the members asked me. I have no objection to the power of assessment sought, because I am satisfied it will be used chiefly as a guarantee, and will never come into actual operation. I do not think it is a foolish thing to put such a provision into the bill, because it will enable the commissioners to borrow money cheaper than they otherwise could.

Re-examined by Mr. DAVISON: I consider the power of rating essential as a security. I do not think it at all imprudent to leave the price to arbitration. It is generally done when buyer and seller cannot agree upon terms.

Mr. *W. Symons*, examined by Mr. CLERK.

I am president of the Working Men's Association in Dundee. It is an association for the protection of the interests of the working men. I think it numbers about 4000. Early in last year our attention was called to the gas companies amalgamation bill and their money bills. We understood that for many years there was some agreement between the companies which destroyed competition. The working men are all gas consumers, and deeply interested in the gas question. There was a meeting of the association on the 16th of January last year, and another meeting on the 15th of February last year, at which it was unanimously agreed to memorialize the Town Council to purchase the gas-works. This association, which represents the great bulk of the working classes in Dundee, highly approves of the steps taken by the council to resist the demands of the companies, as also the negotiations entered into by the council with the companies for the purpose of acquiring the works. There were several subsequent meetings of it. There was also a public meeting of the inhabitants in May, by which time the agreement had been entered into. That agreement had been for some time before the public, and was unanimously approved of at that meeting. The great bulk of the working men, I believe, are convinced that the transfer of the gas-works to a commission would be for the benefit of the community. The great majority of them consume gas, and have a large interest at stake. They have no control over the gas directors at present, but, if the commissioners were appointed, they would have a voice in their election. I think there would be a saving in management, and the public streets will not be so much interfered with as at present. Double mains would be done away with. The guarantee-rate has been discussed several times at our meetings, and the working men are convinced it will never operate injuriously to the consumers. We think that, by affording them security, they will be able to borrow at a lower rate of interest.

Mr. CLERK: The provost has told us there were several objections to the bill by the Working Men's Association. Is there any point now in the bill by which the working men think the agreement is falsified?

Witness: The only point, I think, is the constitution of the commission. We preferred that the council themselves should be the commissioners, as being the true representatives of the public. An opposition to the bill has been raised by certain of our members, and, on the 8th of April in the present year, a resolution was proposed to transfer the support of the association to the Chamber of Commerce, but the idea of such a proposal was negatived by 13 to 3. The chamber were then petitioning against the bill.

Cross-examined by Mr. RICHARDS: The Working Men's Association elected a committee (of which I am one) to do all they could to help the council to carry their bill. That was all the authority I had. A report was presented to the association in December, but I do not remember the exact date, in which there was a clause approving of a provision in the bill that the assessment raised for gas should be repaid by the commissioners to the Police Commissioners within three years, to reduce the police-rates. There is no provision of the kind now in the bill. It has been altered; but I quite agree with the alteration, and the guarantee-rate as security. I consider it quite prudent for the council to take over the gas-works, with all their obligations, for I rely upon the justice of arbitration. I do not know the value of the works, but I consider the council will get them for what they are worth. I think it more advisable to take both works than the new company's merely, as it would be better in the end for the town. The working men are anxious to have the gas as low as possible.

Re-examined by Mr. CLERK: I have heard that the repayment clause was rejected by Lord Redesdale because the incidence of that clause would fall upon different parties from those who got the benefit of the low rates of gas. I am rather favourable to the alteration.

Mr. *R. Strachan*, examined by Mr. CLERK.

I am a member of the executive committee of the Working Men's Association. I have attended nearly all the meetings of the association with regard to the progress of these gas bills. I concur with Mr. Symons that the Working Men's Association are very desirous that the council should get the gas-works. At one of our meetings Mr. Valentine proposed that the committee should not be instructed to go to London. Mr. Cooper, who seconded that resolution, a few days afterwards made a motion that we should transfer our support to the Chamber of Commerce. He represented that our objects and theirs were so much alike that we should join. That motion was rejected by 13 to 3. I should say most decidedly, from my experience, that the feeling of the public of Dundee has not changed with regard to the gas. The alteration as to the repayment clause regarding the assessment we considered, but we did not think it a material difference, for this reason, that the commissioners are so to fix the price of gas from year to year as to yield a sufficient sum to pay all expenses.

Cross-examined by Mr. POPE: The numbers in favour of a guarantee, assessment formed but a very small minority. That question, however was never discussed before the association, but only in the executive committee.

Re-examined by Mr. CLERK: Long before that meeting the agreement had been considered by the Working Men's Association, and approved of. The guarantee-rate was in the agreement, and that agreement was approved of with certain exceptions, all of which have been altered in terms of their recommendation except the one about the constitution of the commission. The question of the guarantee-rate was not one of them.

Mr. *J. Lang*, examined by Mr. CLERK.

I am managing proprietor of the *Dundee Advertiser*. Our firm are consumers to the extent of between £130 and £140 a year. I was present at a meeting at the Thistle Hall, in October, to consider the question whether the council should prosecute the proposed bill for transferring the gas-works to public commissioners, or should abandon the scheme. The hall was crowded. I submitted a series of resolutions in favour of the Town Council proceeding with the bill, which were carried unanimously. The opponents of the bill have never ventured to call a public meeting against it. In my opinion it will be much in favour of the consumers if a body of commissioners, such as are provided for in the bill, undertake the supply of gas in Dundee.

Cross-examined by Mr. POPE: I have endeavoured to take my share in forming public opinion on this question. I have endeavoured honestly and candidly to express my opinions.

Witness was cross-examined at some length with regard to several articles which had appeared in the *Dundee Advertiser* (extracts from which were read), in the course of which he said: I would not have admitted the word "business" into the bill if it had been left to me, because it was not in the agreement, and I would have adhered strictly to the agreement. But now that it is there, and having read the expression of the opinion of Mr. Lloyd, the referee, as to his understanding of the manner in which the arbitration will be conducted, my objections to it have been very considerably removed. I have little doubt that when the arbitration takes place the arbitrator will value the works as a "going concern," and not as dead plant, and that he will have regard to their productive power, and also to the profits they are making. I still think there would be great advantage in having the price fixed by amicable arrangement. At the same time, I have not the least doubt whatever that arbitrators appointed under the Lands Clauses Act will give a decision satisfactory to the whole community of Dundee. I think it is quite proper that the known debts and liabilities of the companies should be scheduled in the bill. It is quite possible, I think, if the bill were passed, that the price would be fixed by agreement.

Mr. POPE: It is quite possible, after they can calculate the effect of the Act upon their shares; but we would prefer that it should be done before the Act passed, and that they should give all their debts and liabilities to be scheduled.

Witness: I think so too; nor do I think that the gas companies, as honourable men, have any reason not to agree to that being done.

Re-examined by Mr. CLERK: We have no means in Dundee of making the companies become reasonable, and therefore arbitration is our only resource. I interpret the agreement of last year as one for a voluntary sale, and I do not think the companies have committed themselves to a different view of it, so it is left entirely open to the arbitrator to decide. My opinion is that the arbitrator is to be appointed under the provisions of the Lands Clauses Consolidation Act.

The CHAIRMAN: Does not the Lands Clauses Act involve the principle of a compulsory sale?

Witness: No. It seems to me that where the parties amicably agree that they will have the price fixed by an arbitrator, it is an amicable agreement to go to arbitration.

Mr. POPE: The question the chairman put is a very important one, and quite correct. The Lands Clauses Consolidation Act would only apply to lands taken "otherwise than by agreement."

Witness: But here they entered into an agreement before going to arbitration. They say—"If we cannot fix the price ourselves, we shall leave it to arbitrators to decide in this manner," and that does not seem to me to involve the principle of a compulsory sale.

Mr. BONHAM-CARTER: In coming to an agreement as to the price, the arbitrators would be named, would they not, without any regard whatever to the Lands Clauses Consolidation Act?

The CHAIRMAN: Would be named by whom?

Mr. BONHAM-CARTER: They would be named by either side. (To witness:) You said just now that you probably could settle this thing by agreement. A settlement by agreement, then, is done by arbitration after all?

Witness: Yes; but where there is an Act of Parliament insisting on the purchase of the ground, it is not so. It seems to me to stand thus:—We resolve that if possible we will bargain, and that if we cannot agree in our bargain then we agree that the mode of procedure prescribed in the Lands Clauses Act shall come into effect.

Mr. BONHAM-CARTER: There is clause 250. Will the arbitrators and overman mentioned in that clause (which leaves it open to say whether it is a voluntary or compulsory sale) be appointed under the Lands Clauses Act?

The CHAIRMAN: And how is the arbitrator, who is himself appointed under the Lands Clauses Act, which only applies to a compulsory sale, to arbitrate in favour of its being a voluntary sale?

Mr. HOPE SCOTT: Merely in this way. He is simply appointed according to the forms of the Act, where there is no agreement. But to the arbitrator here to be appointed according to the forms of the Act there is an instruction, asking him to treat it either as a voluntary or a compulsory sale. It would simply be a direction to him to do this before proceeding further.

Mr. BONHAM-CARTER: And it is simply a way of saying that the arbitration is to be according to the forms of the Lands Clauses Act.

Mr. HOPE SCOTT: I was named as one of the referees to settle any disputed point in the bill, but was out of the way, and Mr. Lloyd considered this matter, and settled it by leaving it open in terms of the agreement.

Mr. BONHAM-CARTER: And these words are simply explanatory.

Mr. HOPE SCOTT: They are directory. And they say to the arbitrator—"Don't suppose when you begin this you are bound to make it a compulsory sale." But it is left for the arbitrator to decide first whether it is a voluntary or a compulsory sale, and that is so much in favour of the public purchasing.

Mr. *R. Isdale*, examined by Mr. HOPE SCOTT.

I am a merchant and manufacturer in Dundee, a landed proprietor in Fife, and have been a member of the parochial board for eight or nine years. In that capacity I come in contact with all classes. I have considered the scheme of the council for the transfer of the gas-works, and am in favour of it. I consider the general feeling in Dundee is the same. I believe the present monopoly will sooner or later prove injurious to the community. I conceive that the legislation of last year in favour of the companies would give them considerable advantages if they remained independent, and I should dread any delay in taking their undertakings, lest they should be put at a higher value under the Act of last year before the council could agree to purchase. What I anticipate is that the gas will be made as cheap and as good a possible, and that the corporation could do both those things better than the companies. We shall then get rid of the complaints about opening the streets. There are a good many complaints now about the quality of the gas. I think the petitions against this scheme represent a very small portion of the community. I have seen the petition of the ratepayers against the bill, but I do not consider it is a fair representation of the community. I do not think there are above 70 well-known names in the petition. There are very few shopkeepers names in it, and some of these names occur twice. There are some signatures rather in the style of hieroglyphics, and others in the form of a cross. E. D. Lyons signs in two petitions. There is a whole sheet which appears to be signed by the Messrs. Cox's workers in Lochee, and other sheets seem to be all in the same handwriting. At the Arbroath Railway Station I witnessed two sailors who were on their way to Aberdeen sign the petitions, after being persuaded to do so, and it was represented to them that their names would appear in the House of Commons. I have seen boys sign the petition near my shop in the High Street, trying their hand. I attach little importance to that petition. The petition by traders professes to be signed by 451 persons, but I find firms sign it also as well as the individual partners of the firm. First, there is the firm which signs—for instance, Cox Brothers—and then there are six partners who sign afterwards. That firm appears twice. Smith, Mitchell, and Co., have five signatures in the petition. There are 360 signatures representing mill managers, porters, clerks, &c., connected with manufacturing firms in Dundee. I include in the town Lochee as well. There are 149 members in the Chamber of Commerce, and 37 have signed against this bill. Large consumers get a discount from their gas accounts from 2½ to 10 per cent. There is a likelihood of their not getting that from the new commission, and that would dispose them to oppose the bill. The petition in favour of the bill is signed by nearly 15,000 persons. It is not only numerously, but respectably signed, containing the names and addresses of all the leading shopkeepers in the town, and the middle classes. That petition is far more important, as showing the state of feeling in Dundee, than the other petitions. For my own satisfaction I picked out 160 names of gentlemen in the petition who are doing business in the centre of the town. There are about 90 or 94 large consumers, and 29 of these only sign the petition against the bill.

Cross-examined by Mr. POPE: To the best of my knowledge there are not 20 signatures of females out of the 15,000 appended to the petition. If there were 5000 I should not think it a great matter for astonishment, as there are a great number of females in business, paying rates.

Mr. POPE: In your opinion, is the opposition of the large traders to this bill dictated by the assumption that they will not obtain a discount in their large accounts?

Witness: I have not made any such assumption.

Mr. POPE: You have said that you thought their opposition to its being in the hands of a commission arose from the fact that they would not get their discount?

Witness: I said that might be an element in the question. I think that if a man can get £100 worth of a thing for £90, that is always an element to be considered, and I do not think they will get that from the commissioners, because I believe that by the proposed change all parties will be put upon the same footing. A man who pays £29 is in my opinion as much entitled to discount as a man who pays £30.

Mr. POPE: You thought the legislation of last year had given great advantages to the companies, and that that was one of the grounds for the speculation which had been going on in their shares, and not the prospect of a good price from the corporation. What are those advantages?

Witness: We do not have the same check over the companies now that we had previously. We have not the same means of compelling them to give us gas equal to the best in Scotland, that we had before under Hume's clause, although we did not require to enforce it.

TUESDAY, MAY 26.

Joseph Heron, Esq., examined by Mr. HOPE SCOTT.

I am town-clerk of Manchester. The gas and water supply are in the hands of the corporation. The money required for the gas-works has been borrowed on the security of the rates, and the gas-works. In the case of the water-works, we had to buy up existing companies, and we have expended very nearly £2,000,000, which was borrowed on the security of a rate. The gas has always been in the hands of the corporation. I have no doubt that it is the best way to have the gas and water in the hands of the corporation. In Manchester we have expended upwards of £1,000,000 in city improvements out of the profits of gas, and kept our rates down at the same time. The highest price is 3s. 2d. per 1000 feet, and the average illuminating power last year was 21 candles. I am not aware that we have had any complaints of the profits being applied to public improvements. It was expressly provided in an early Act that they should be so applied. If it had been an open question no doubt there would have been an agitation that the profits should be applied in reduction of the rates.

By the COMMITTEE: The million pounds have been expended after paying interest on our borrowed money and providing a sinking-fund. The water supply is different. There is a general rate upon all property for water, even though none is given, which rate is paid in consideration of the advantages of an abundant general supply of water. Then there is a domestic rate levied upon all houses; so that in that case we have really a rate in aid. And in the case of the gas-works we are entitled to pledge the property of the corporation. We make from £30,000 to £60,000 profit, and we try only to make such legitimate profits, 10 per cent. or so, which would be allowed to a private company. One great advantage of our power of assessment is, that we can borrow money very cheaply—at about 4 per cent. We make a very good steady profit, and it is well known that gas-making is very profitable. I think a large profit would arise in Dundee, as in Manchester, from the increase of population, and the consequent increase of consumption, from the union of the two companies into one, and there being one set of plant instead of two; and then the surplus profits, instead of being applied, as with us, to public improvements, would be devoted to the reduction of the price of gas, so that the security which a man gave in the shape of a rate he would get back in the form of cheaper gas; but unless there is to be security the scheme is utterly impracticable, for the very idea of saying that these parties are to give over their works and property without being paid a capital sum, or without security for the annuities, is absolutely absurd. It would be a speculation all on one side; and some day they might just be laughed

at when they went to seek payment of their annuities. In Manchester we now almost always lay down the pipes on both sides of the street, under the foot-ways. We prefer the foot-ways rather than the carriage-way, because it is found to diminish damage to the pipes, as also to prevent a large expenditure from the rates on street repairs. Having both the water and the gas in our own hands, we always arrange to have the committees of water and gas, if possible, engaged in their repairs on the same street at the same time. I do not think it is in any way hazardous for the people of Dundee to come to an agreement to take the gas-works by arbitration. I do not see how it was possible to do otherwise. It could not have been done just now unless the corporation were to accept the price of the gas companies; but there is just as much risk in going to arbitration that the price will be fixed too low for the companies as there is that it may be too high for the town.

Mr. HOPE SCOTT: You have had some experience of arbitrations. How are they conducted?

Witness: Well, the net annual profits will have to be ascertained.

Mr. POPE submitted that the witness's understanding of what would take place before the arbitrator could hardly be taken as evidence on this point, as this was an arbitration to take place under the agreement.

Examination resumed: No arbitrator, in ascertaining the value of gas or water works, would take the value of the pipes. His first inquiry would be "What is the income which is now being derived by the present proprietors from the business in gas?" He would then consider whether he would allow anything for prospective increase, looking at the terms of the agreement and to any particular clauses bearing on the question of what they are entitled to receive. Then the gas shareholders would be paid by a capitalized sum, but if it is not convenient to pay a capital sum, then it will be done by annuities fixed in relation to the capital sum.

By the COMMITTEE: If an arbitrator found, for instance, that a company were making 20 per cent., he would not take that as the standard, because he must take into consideration the terms of the Act of Parliament under which the company is acting; and if he finds that the company is only entitled to 10 per cent. he would take that into consideration, and would say, "That is the utmost extent of dividend Parliament ever authorized you to make, and if you have been making more you have not been carrying out the powers entrusted to you by Parliament. You ought to have reduced the price of gas to that extent," and he would, of course, disallow it. He would take an average of years and the prospective increase which might take place to a certain extent; he would also take into consideration the risk—the lime light, for instance.

Examination resumed: People are very glad to take corporation bonds at 4 per cent. who would not lend to other parties at 10 per cent. Arbitration under Act of Parliament is an almost universal proceeding.

Mr. BONHAM-CARTER said the witness had better confine his evidence to two points. One was as to the fixing of the sum to be paid before coming to Parliament or not, and the other as to the guarantee-rate as the security for the annuities.

Examination resumed: I do not see any difference between a man paying his rate as an increase on the general rate, or separately to the Gas Commissioners. [Witness then quoted the Acts of a large number of towns in favour of taking gas-works by arbitration, and of levying rates in aid if necessary.]

The CHAIRMAN: I think we have had sufficient evidence on that point, but I should like the Glasgow Water Act to be put in. [The same was handed in.]

By the COMMITTEE: In all these instances there was a limit to the sum borrowed, or to the rate. Parliament would not grant a rate without limit. The case of the Stockport Water Company was exactly similar to this. The corporation brought in a bill for a competing company, which Parliament thought unjust, and they turned the bill into a bill for the purchase of the works of the existing company, and made it compulsory on the corporation to take them at their value by arbitration.

Cross-examined by Mr. POPE: I am aware of the powers the Dundee Town Council already have as to taking over the new company, but I think that would be a most undesirable arrangement, for it would induce a ruinous competition between the town and the old gas company immediately, which would neither be for their benefit nor, in the end, for that of the public. No doubt it is a convenience to have the gas and water supplies in the hands of the corporation. Manchester never had to buy up a company, but started the gas-works itself. The money borrowed for the works is on the security of the rates.

Mr. POPE: Assuming that the corporation of Manchester should fix the price of gas lower than the cost of production, what means have they of recouping themselves?

Witness: If such a thing were possible, we should have to pay the loss out of the borough funds.

Cross-examination continued: I am aware that it has been thought desirable in Dundee to constitute a gas commission, and to give them the power of raising a rate. If the inhabitants generally take gas, they will be willing to pay for the gas a price which will repay all expense of the gas-works; but if there should be loss, the levying of a rate to meet that would only be taking from them in another way what they should have paid before for their gas. A public rate would be chargeable upon all, whether consumers of gas or not. Supposing a man is not a consumer, and pays his gas-rate, he will get no consideration for that. In the case of water, the general public get a consideration for the rate.

The CHAIRMAN: But in the case of gas, the ratepayer gets the benefit of the lighting of the streets.

Witness: I quite agree in the suggestion that they do get the benefit. We make the public at large pay for the supply of water, and the public in the same way pay for the gas.

Cross-examination resumed: The public commissioners will not light lamps for nothing, and the expense of lighting will be a charge on the commissioners. The commissioners will be sellers of a commodity which the public will pay for. In the case of water there is, perhaps, more advantage gained by the public than from gas. Several large towns have adopted a public rate for water for compensating to some extent the general supply of water, quite irrespective of the benefits got in another form. As to arbitration, I do not know that there is any distinction between that under the English and that under the Scotch Acts. I do not know anything about Scotch arbitration Acts. If the profits of the old gas company are unlimited by their Act of Parliament, then the corporation must pay the amount of profits to the company which they were making, because there was no limit to guide the arbiter. I do not mean to say that you are to guarantee that amount of profit, but that would be an element in the consideration, taking into account all other circumstances. Assuming that the agreement were out of the way, the price might be settled now, and the price put into the bill.

Mr. POPE: Do you not think the powers of the corporation as to taking over the new company would be a screw by which—if they put them in operation—they could compel the old company to come to terms?

Witness: Probably it might; but I should think that was a course few would be prepared to adopt. If a party is willing to sell his property at a fair price by arbitration, that is all, I think, that people in general, as well as corporations, ought to expect. I do not know of any instance in which a separate body has been constituted, with new powers of rating, where they have purchased the company without a price being fixed by agreement beforehand.

By the COMMITTEE: I do not think any special advantage would accrue to the public by the price being settled beforehand. I am satisfied that if the price had been fixed the probability is much in favour of the price being higher than it would be fixed by arbitration. Where it is a compulsory purchase under the Lands Clauses Act it is the practice for the arbiter to add a certain additional value. It is quite certain if you attempt to fix the price by agreement the probability is that a great deal more will be given than would have been allowed by the arbitrator under a compulsory sale. The selling parties know they must get a price, and they are sure to put in a sum greater than the arbiter in any circumstances would give. But where it is left to the arbitrator to consider whether the sale should be compulsory or voluntary, and where parties have agreed to sell, the only point undecided is the price. Then if they agree as to the mode in which the price is to be determined, it would be a question for the arbitrator whether the sale might be compulsory or voluntary. I am satisfied that the price will be higher in all cases by agreement than were it fixed by arbitration.

Mr. DENISON said that was the case for the promoters.

Mr. POPE said he would call his witnesses before addressing the committee.

Mr. *R. Sturrock*, examined by Mr. POPE.

I am secretary to the Dundee Chamber of Commerce, which is a voluntary association, consisting of merchants and manufacturers, and incorporated by Royal Charter in 1864, and its functions are to watch and encourage the commerce and manufactures of the town. The chamber has always taken great interest in the affairs of the town. The number of members last year was 157, of whom 140 are in Dundee, and the remainder large manufacturers in the counties round. All the principal traders and merchants of the town are members. Messrs. Baxter Brothers employ 4000 hands, and Messrs. Cox Brothers from 3000 to 4000. There are other firms of the same magnitude. The petition against the bill represents the almost unanimous opinion of the chamber. The resolutions on this bill were come to on the 10th of February. There were 47 members present, representing 67 persons. It was the largest meeting but one ever held of the Dundee Chamber. Of those 47 members only two dissented from the resolution to petition against the bill. The opinion of the chamber has not undergone any change. The gentlemen who submitted the resolutions are partners of large firms. The petition of traders is supplementary to, and in support of, that of the chamber. The traders petition is signed by 19 members of the chamber who were not present at the meeting on the 10th of February. The petition was also signed by 23 considerable traders who are not members of the Chamber of Commerce. The mills and manufactories of Dundee are entirely lighted with gas, and the gross amount paid by the gentlemen representing the Chamber of Commerce or signing the petition is £11,000. Messrs. Baxter Brothers pay about £800 a year. The gentlemen who petition against the bill are the largest gas consumers in Dundee. The gross rateable value of property in Dundee is £320,000, of which the rateable value of property connected with the staple trade is £70,000. The manufactories in Dundee are at present assessed for local taxes at the rate of 5*s.* 1d. in the pound, including the water-rate, but excluding the water-rate the amount is 3*s.* 7d. For general police purposes—including also general purposes, sewage-rates, and public health—the taxes amount to 1*s.* 9d., whereas they have the power of assessing them to 2*s.* 5*s.*, so that they have a reserve power of 8d. The movement to take over the gas-works commenced in 1866. It is not within my knowledge that there were any complaints of the quality of gas previous to that date. The average price of gas, in the seven towns which have been already alluded to, from 1860 to 1868, has been 5*s.* 1d. per 1000 feet, and in Dundee the average has been 5*s.* The average illuminating power of the gas in the seven towns was 29 and a fraction, while in Dundee it is 27 to 28 candles. The average dividend for six of those towns was 8*s.* 11d., while in Dundee it has been 4*s.* 0½d. In 1867 the original stock of the old company was selling at £50 per share. On the 13th of March last the price was, and it is still, £63 per share. That rise of £13 was no doubt due to the agreement made with the corporation. After the agreement the old company issued £50,000 of new £10 stock, which has been sold at a premium of £2 10*s.*, while the operation of conversion of debt has been going on with reference to the new company.

Mr. POPE: Are you able to point out to the committee any public grounds of complaint which render it necessary that the present state of things should be altered?

Witness: There were no complaints prior to the agreement.

Cross-examined by Mr. DENISON: Do you consider the companies in a position of competition or agreement?

Witness: I am here as the secretary to the Chamber of Commerce, and I abstain from interfering in these matters; but, to a certain extent, from the arrangement, you may say they are both. At the present moment they have an agreement which prevents competition; but if the companies were to do anything to raise the price, it would create a feeling against them, and the magistrates would have the power to step in and purchase the works of the new company. I believe it is the habit in Scotland to give in arbitration more than the market price. Since the agreement has been made with the companies there have been complaints against the quality of the gas. The repeal of the Hume clause could not be of much advantage to the companies, because it was unworkable.

Mr. DENISON: If you found one town in seven better than Dundee, would not the Hume clause be brought in?

Witness: You must go all round the seven towns to see which is the best, which would have a certain difficulty attending it.

The CHAIRMAN said the committee had enough evidence on that point.

Cross-examination resumed: As to whether the chairman said at the meeting of the chamber on the 25th of March, that it was their intention to alter the bill rather than throw it out, the chairman will explain that himself. Mr. Yeaman is a director of the Chamber of Commerce, but he is not engaged in the staple trade of Dundee. The amount which the petitioners pay for gas is said to be about £11,000 a year. The amount paid by the whole chamber is £7600 a year. Those who pay the £7600 have petitioned almost unanimously against the bill.

Mr. DENISON: How do you make up the remainder of the £11,000?

Witness: By parties who have mills and factories.

Mr. DENISON: But you do not represent all those as signing the petition?

Witness: It includes all large traders in Dundee.

Mr. DENISON: Does the petition include all large traders?

Witness: I cannot say the whole.

Re-examined by Mr. POPE: The petition by the chamber is under the seal of the chamber, and of course it represents all the members. There are other traders who are not members of the Chamber of Commerce who have have signed the traders petition.

Mr. *H. C. Briggs*, examined by Mr. POPE.

I am partner of the firm of Thomson, Shepherd, and Briggs, of Dundee. I am not a member of the Chamber of Commerce, but Mr. Shepherd is. We employ from 1600 to 1800 hands, and we pay £450 a year for gas. We have been engaged in business in Dundee for about six years. We have been supplied partly from the old and new companies. I never heard any complaint as to the quality of the gas until the agreement was entered into. I have heard that the magistrates have not put in force their powers for regulating the quality and price of gas. The gas companies have been trying to increase their dividends, while the corporation has neglected to restrain them, as might have been done in terms of the agreement. Up to 1867, I believe the price of gas in Dundee was reasonable, taking the price of coals and other things into account. I think the clause obtained in place of the Hume clause is more workable than the latter. There are forcible penalties in the new clause which were not in the Hume clause. I concur in the resolutions of the Chamber of Commerce. I consider the agreement sought to be legalized is an imprudent and speculative transaction. One of my reasons for objecting to the agreement is, because the full amount of the capital is guaranteed, and yet the companies are to have power to obtain the value of their stores, or of the debts which may be due to them. No doubt a certain portion of that is working capital; besides, the town will have to provide additional capital for working out the agreement. The stores and debt represent a portion of the capital of the companies so invested—I think somewhere about £12,000—but still the corporation are to pay over to the company annuities upon their full capital; in point of fact, they are to pay upon what the corporation will take to themselves.

Mr. BONHAM-CARTER: But the arbitrator would surely take that into account?

Witness: It is not so stated; it is left open and undefined.

Mr. POPE: Supposing the whole of the stock, debts, and plant of the companies to be valued to the corporation, and that valuation to be paid, not in a slump sum, but in the form of an annuity proportioned to the actual value of the property required, what objections do you feel to that arrangement, and how do you anticipate that the arbitrator would fail to deal with it in a proper way?

Witness: The arbitrator might take that into account, but certainly, reading from the agreement which is contained in the Act, it is not left at all to the arbitrator; it is just left open.

By the COMMITTEE: The second clause of schedule A states that the annuities shall be paid on the amount of the share capital of the companies as existing, but by the fourth clause it is provided that the company shall be paid the value of the stores on hand, and be entitled to all the revenues, balances, and arrears. A certain portion of the capital in the second of those clauses is invested in the stores and arrears, so that it appears to me the company would be receiving them twice over.

Examination resumed: I am aware that there is a clause sought to be introduced laying the cost of the arbitration upon the corporation, and that appears to me to be offering a premium to the gas companies to prolong the arbitration, and bring every professional aid to increase the value of their works. Delay would cause no loss to the companies, because they are to receive their dividends meanwhile. I think that my opinion with regard to the probable and speculative nature of this agreement is shared in by the large traders in Dundee. I know that the gas companies shares have advanced in price in consequence of the agreement. I think a practical gas manager and a board of directors who are personally interested can manage gas-works better than a board of inexperienced or unpaid commissioners. I have no ground of complaint against the existing state of things. The quality of the gas is good, and the price reasonable. I think the proposed agreement should be much more definite than it is. I cannot find in it any guarantee against undue assessment, nor any limitation as to the price of gas, while as to the illuminating power the only thing is with reference to the 18 candles.

Cross-examined by Mr. DENISON: The definition as to what the perpetual annuities are to be is left to the arbitratorr. I do no not know what provision there is in the Lands Clauses Act about the costs of arbitration. I complain that a large amount of the rates will be thrown on property which does not consume any gas. I have not thought of the question whether more than 18-candle gas should be stated in the bill.

Re-examined by Mr. POPE: If a rate were made it would fall upon property irrespective of consumption of gas. I would rather pay for the gas I consume than be rated for any property upon which I did not consume gas.

Mr. *J. Don*, examined by Mr. POPE.

At the time the petition was presented against the bill I was chairman of the Chamber of Commerce. That petition represents my opinion, and the opinion of a very large number of persons in Dundee. The minority of the chamber against the bill is very small. With regard to the meeting at which 47 members were present, these gentlemen represented a very large amount of property; and the adoption of the resolutions, notwithstanding the protest of Bailie Yeatman, did represent substantially the feeling of the meeting. There was nothing peculiar about the meeting; it was public, and some were coming and some were going. Most certainly the resolution fairly bound the other members of the chamber to the action of their executive. The chief grounds of our opposition are that we thought the affair an unbusiness-like proceeding; that the community would be liable to a heavy tax; and that we should have some idea of the price which might be paid for the two properties. As far as my experience goes the supply of gas to Dundee has been satisfactory. After the new company stated in 1846 the price of gas was reduced very materially by the pressure of competition. After the companies came to an understanding the result was still to lower the price gradually until last year, when the companies and the corporation came to an agreement. Since then it seems as if the companies had been trying to increase their dividends, the corporation standing quietly by. Under these circumstances it does not excite my surprise that complaints have been made of the companies since the last agreement. I attach no importance to the repeal of Hume's clause, because I think the present is a fair one. Hume's clause was never enforced. The clause of last year has power of enforcement; and I would rather have that clause than be left to the provision in the present corporation bill. Dundee is already heavily assessed. The traders petition represents an influential number of the citizens. The Chamber of Commerce represents the staple trade of Dundee, and they are all but unanimous against the bill.

Re-examined by Mr. DAVISON: There are 140 town members in the Chamber of Commerce. The rateable value of the property of these members is more than £65,000, but I cannot say whether the rateable value of the 47 members who were present at the meeting would be £32,000.

Mr. DAVISON: Did you state at a public meeting on the 25th of March that you were coming to London to aid the Town Council not to fight against them?

Witness: At that time the negotiations were going on. We wished the companies to say how much they wanted, but they have never done so. In fact, the Town Council went into the agreement in entire ignorance of the bargain they were attempting to carry out. That is the main fault we find with them as men of business; and I put it to the committee whether or not this is the way to carry out such a transaction, and whether it is right to attempt to impose an assessment upon us for such a purpose. I should like to see the price fixed just as I should do in my own business. Supposing I were to buy a gas-work or a mill, I should first ascertain what would be the cost of erecting a new one, and of everything necessary to carry on the business. Then I would get competent persons to value the old works, and deduct a fair sum for deterioration. Some of these works have been in operation for 40 years, and some of the pipes have been lying in the earth for 30 years, and consequently there would be a serious deterioration in the quality of the article. If the owners of the old works were to ask as much money for the old as for the new, I would have nothing to do with the old. I hold that that is exactly what the Town Council have done—they know nothing about this plant. As a matter of principle, I object to any public commissioners carrying on a hazardous enterprise. I think the community in a matter of this kind are entitled to know the price they had to pay, and if the companies asked too much I would break off the transaction. I would not leave it to a skilled arbiter to settle the price unless I were satisfied. Whether Parliament would sanction a third company in Dundee would depend upon the pressure put upon them. I can imagine Dundee increasing so much as to require a third company. The question whether it would not be of advantage to the consumers that a public body should have the future expenditure for gas purposes in Dundee depends entirely upon the price at which the works are sold to the public. I believe that the commissioners could raise money under less interest than that of 10 per cent.; they might get it at 5 per cent., or even less. Of course it would be better to get money at 5 per cent. than pay 10 per cent. for it, and it would be better to raise it at 4½ than 5. I would have no difficulty in lending money to the commissioners without there being a guarantee rate, as I would have the security afforded by the works and the gas-rates. I am a gas shareholder, but not in Dundee. It would depend upon the annuity to be paid whether I would hand over my shares to any body which might be created. If I had 10 per cent. instead of 5, I would take it upon that risk.

Mr. DAVISON: How could you be secured for the first year or half year except by a contingent gas-rate?

Witness: By a lien on the gas-works and the gas-rate.

Mr. DAVISON: Supposing the commission lowered the price to one which they were advised would pay the annuities, but failed to do so, by say £10,000, can you tell me any machinery except that of a contingent gas-rate by which it could be made up?

Witness: No, I cannot.

Re-examined by Mr. RICHARDS: I understand that the price has been raised in almost all the seven towns which are to regulate the price in Dundee. The Harbour Trustees have been able to borrow money on their works. If the commissioners enter upon the possession of a gas-work which has been a profitable concern, I think there would be no difficulty in raising money upon it. They have the power of taking a sinking-fund, and so far they can offer the same security as the Harbour Commissioners, but they have a power of assessment in addition. I have no faith in a commission selected from different classes of society. If we are compelled to take over these gas-works, I think it would be much better to pay a lump sum for them. I do not think there would be the slightest difficulty in so doing. No doubt then we should have a chance of getting them at a fair value, and we ought to get a discount.

THURSDAY, MAY 28.

Mr. *N. O. Dalgleish*, examined by Mr. RICHARDS.

I am a partner in the firm of Messrs. Baxter Brothers, who carry on a large business in Dundee, and employ between 4000 and 5000 people. We pay about £800 a year for gas. I have watched the proposed transfer of the gas-works with interest, but I think the transfer both inexpedient and unnecessary. I think we are in a much better position now in regard to the supply of gas by the gas companies than we could be with any public commission. The clause in the new company's Act giving power to the council to take over their works I think secures us competition, because, under the existing agreement of the two companies, if any injury arises to the public, the council can step in and purchase the new company's works under clause 58 of their bill. That works with a moral force on both companies; the council having the power, if they wish, to purchase the new company has the effect of preventing the companies doing anything which would be prejudicial to the town. We have had the advantage of the average price of the seven towns. During the last nine years the companies have actually supplied gas at 1½d. per 1000 feet less than they were entitled to charge. The Hume clause is not worth the paper it was written on. The clause as to the average illuminating power is much better, because there is also power for enforcing that clause. The legislation last year put Dundee in a better position, both in regard to the supply of gas and its price. I have read a statement put out by the new company in 1862 that, in consequence of the reduction of the price of gas in the seven towns which regulated the average price of Dundee, and the falling off of profits in contrast with previous years, they recommended that a dividend of only 3 per cent. should be declared on the general stock of the company. The average clause, therefore, had the effect of reducing the price of gas, and the gas directors had to be satisfied with a dividend of 3 per cent. The average clause could be applied, I think, by any child. The gas-works of the companies have for some time been under one management, but the directorate, the shareholders, and the interests of each have always been distinct and separate. In May, 1855, the new company reported that an agreement had been come to with the old company, representing that it would result in a saving of expenditure. I think that agreement and the clause giving power to the council to purchase the new works has had a good effect on the supply of gas in Dundee. The price of the shares has risen very much since the agreement. I calculate that the total advance in the value of the stock of both companies is about £38,000.

By the CHAIRMAN: I do not think any arbitrator would be at all likely to give the companies less than the market value of their total share capital. The rise in the price of shares will increase the standard in ascertaining the price to be paid to the companies. The £38,000, I think, fairly represents the increased value which has taken place in consequence of this agreement. I do not think there should be an assessment to back the deficiency of the price of gas. I do not see why the commissioners should not be able to borrow money without such assessment. The Harbour Trustees obtained loans, even after they were almost bankrupt, without an assessment-rate.

The council's balance-sheet shows a surplus of £40,000; and that would give them fair credit in the market. I should prefer the Town Council to a commission, as the managers of the gas-works. I do not object to the handing over of the works under a fair and honest bill, but I object to the principle of transfer under this bill. There is no maximum price of the works fixed, and we are left to the mercy of the arbiter, who has power to decide by the bill whether the sale shall be voluntary or compulsory. I object to that. The buyer ought to know the amount of the obligations of the companies before he agrees to take over the works.

A list of the mortgage debts of the new company was handed in, and Mr. DAVISON said there were no debts of the old company.

Examination resumed: The object of the Chamber of Commerce is to look after the interests of industrial property in Dundee; it has no other object. It has no bearing on anything connected with wages, or anything connected in that way with trade. Many of the large consumers are shareholders in the gas companies.

Cross-examined by Mr. DAVISON: Our firm get a discount of 10 per cent. We have never taken into account the question whether we should get the discount if the works were in the hands of the corporation. It is not an element in our opposition. We have had several meetings of the Town Council, but the matter has never been mentioned. I should not object to the transfer if we got a fair and honest bill, under which the interests of the community were safe. There would be no saving to the public if the corporation had to pay for two works. We have virtually the benefit of competition now, for the companies are under such restrictions that they cannot injure the public. Hume's clause could not be worked without travelling all over Scotland; but, under the average clause, we could easily summon evidence from the seven towns. I put great value on the clause which gives power to the council to take over the new company's works. I cannot recollect whether, after the insertion of that clause, the shares of that company rose in value in the market, as it occurred in 1846. The present agreement is a very different thing from that purchase clause. It differs in this respect, that there is nothing whatever in the clause empowering the council to purchase the works of the new company which gives power to levy an assessment upon the community; whereas there is in this bill an unlimited assessment over the whole property in the town. That is a very important difference. There is no price fixed in the new company's Act. The sale is to be by arbitration; and, after the award is made, if the corporation think the price too high, they need not take the works. Supposing I were to sell my works, I imagine I should get no other security than the works themselves. There are sales every day on that ground. I would not sell them without security.

Re-examined by Mr. RICHARDS? I think the debts of the new company should have been scheduled. By buying under the purchase clause of the new company's Act, the community would be only buying one plant, which would be a great saving to the community. The council have a balance, but they have plenty to do with it. The Police Commissioners have a rate which is not worked up to its maximum. There is an available margin of £4000 or £5000 a year.

Mr. *G. Malcolm*, examined by Mr. POPE.

I am a partner in the firm of Malcolm, Ogilvie, and Co., and we employ about 1000 hands. I know something about engineering. Last year we paid £300 for gas. We are assessed on £1500 or £1600 of rental. I have paid particular attention to the present proposed scheme, and think it is inexpedient and unnecessary, and undertaken very recklessly by the council without due consideration. The agreement between the council and the companies was published at the time it was made. There was no action taken then by any public body. The general impression was that there was no likelihood of the agreement being carried out. On the 27th of September, Mr. Kerr wrote to the chairman of the Chamber of Commerce, stating that the Town Council proposed to act upon the agreement. On the 8th of October the chamber met, and a deputation was appointed to confer with the Town Council. The committee appointed by the Town Council applied for information to a number of towns, and the replies were generally to the effect, that the plan had succeeded in various towns in England; but there was no specific information as to whether it would be good for Dundee. We never led the Town Council to suppose the Chamber of Commerce were in favour of the bill. At the last meeting I stated that I had no authority to discuss the clauses, and I withdrew from the meeting. The draft bill was submitted to the chamber about the 22nd of December, and a committee was appointed to investigate and report. Letters were written to Paisley and other towns asking for information. [Copies of same handed in.] From the time the deputation were first appointed, the Chamber of Commerce did everything they could to get information. The opinion of the chamber was a deliberate opinion on the best information we could obtain. It was not a hasty opinion, we were blamed for not being hasty enough. I anticipate that instead of the community getting a benefit, if the gas-works were placed in the hands of a commission, they would experience the reverse. I have looked into the case of Paisley, and the gas there is 7d. less per 1000 than in Dundee under existing circumstances. That would appear, at first sight, to show some advantage in favour of the works being in the hands of a public body; but I think I can account for that difference, irrespective of the control of the supply, in the fact that at Paisley coal is only 15s. 4d., while in Dundee it is 21s. The coal supplied to the Dundee gas-works last year cost £17,071, while if it could have been purchased at the same rate as at Paisley it would have been £12,464, leaving a difference of £4600. There was also the circumstance that the works in Paisley were taken by the corporation in 1846, and the price fixed before the purchase was made; and there was no guarantee by an assessment. I can see no reason why the shareholders in Dundee should not be content to hand over their property on the same security as the Paisley shareholders were content with. I have looked a little into the case of Manchester. We had a great deal said about that in Dundee at public meetings. The public were told that if the gas-works were transferred into the hands of the corporation, that we would have our gas at so much less—3s. 2d. instead of 5s.—and great profits besides. All this was to be done by following the example of Manchester; but they never took into account the price of coal at Dundee as against Manchester, nor the amount of business carried on, nor anything that might affect the question. One of my brothers sold ten shares on the 11th of December, 1866, for £50 net cash, and between that time and the 16th of last October they have advanced to £62 8s.

Mr. POPE: Are you satisfied with arbitration yourself as the mode of settling difficulties?

Witness: When it is resorted to in circumstances where it cannot be avoided, and where the parties do not agree; but there are very often instructions or terms given to the arbitrator, confining him to certain limits. It would have been a desirable thing for the council to have ascertained how much they might pay for one company, compared with the price for the two.

By the COMMITTEE: The old company's works would be sufficient to supply the town, but the new company would not be able to do so entirely.

Examination resumed: I know that the provision, as originally introduced, was that the arbitrator should make a valuation of the property handed over; but that is now changed to annuities upon the share capital. The works are also to be valued according to "business," which is a new word to me in this respect. If the council had acted wisely, in resolving to buy the works by arbitration, they should have fixed the date at which the business was to be valued. The agreement was come to in March, and the annual balance-sheet of the old company would have been issued at the end of May. It seems to me, therefore, one of the greatest blunders made, that they did not fix that as the date according to which the value of the annuities should be declared. Instead of that, they allow the companies to go on for eighteen months, during which time they had great temptations to show that their dividends were increasing in value. That seems to me another reason why they have introduced the word "business." There have been great complaints in the town since this agreement was brought forward that the gas bills were going up. I have not examined mine, and therefore cannot speak from experience.

Cross-examined by Mr. DENISON: I should not object to a fair bargain, but I do to an arbitrator without anything to guide him. The date should be fixed, and also whether we are going to pay the value of the works, or whether, as a business, according to the profit. I think the latter, to a certain extent. There is such a thing as goodwill, and it ought also to be stated how many years purchase they would give. I cannot say when I began to take an interest in this question. The general impression I gained from every one to whom I spoke upon the matter was that it was not a good agreement for the town. I am not aware that both in Edinburgh and Glasgow arrangements are being made for transferring the control of the gas to the Town Council. I should think the old company's pipes extend nearly all over the town of Dundee. I am aware that both companies engaged that any changes in the clauses relating to quality and price made since the 8th of March, 1867, should not "affect the ascertainment of the price or annuities to be paid for the said works." That is, no doubt, meant to prevent what the companies have done under their Act of last year being taken into account by the arbitrator.

Re-examined by Mr. POPE: I believe both companies have surplus land, which could be applied to extensions of works.

In reply to Mr. BONHAM-CARTER, *witness* said that five years before the agreement the companies were in a very gloomy position. He thought his stock at that time of very little worth; but since the agreement things had quite changed, and the stock had gone up. He also objected to the capitalization of the debt.

By Mr. WALROND: By this bill it is proposed to give Dundee gas at cost price; and if there is any profit it must be from the increase in the price of the gas sold over the cost.

By Mr. RICHARDS: In 1865 the old company paid a dividend of £2 10s. per share; the last dividend was £3 per share.

Mr. *Thomas Smith*, examined by Mr. RICHARDS.

I am a partner in the firm of Henry Smith and Co., in Dundee, and also of the firm of Smith, Mitchell, and Co. I was for five years in the council, and was also a Harbour Trustee. I am an ex-president of the Chamber of Commerce, and have also been Dean of Guild. The port and harbour of Dundee were sold by the council to the Harbour Trustees. The first Act of Parliament was in 1815; but the time when the harbour was sold was 1830. £27,500 were paid for the port and harbour. There was no power of assessment given to the commission; no security except the rates and fees of the harbour. The council got mortgages upon the works and no other security. I was convener for some years of the committee of the Harbour Trust, and had no difficulty in borrowing money, sometimes as low as 3½ per cent., in other cases at 4 per cent. The highest was 5 per cent. We borrowed money to the extent of £200,000 or more. The Harbour Trustees were never in a state of bankruptcy, but the council were very near it. The council got into that condition I believe chiefly on account of the part they took in the water contest, which was similar to this gas contest. I do not think the council would have the slightest difficulty in raising money on their credit, and that of the works, if the works be got at a fair price.

Cross-examined by Mr. DENISON: The Act states a commission is to purchase the works, which commission would have no funds, unless created by Parliament. The price of the harbour was arranged. The council wished £30,000, but the trustees would only give £25,000. They settled the difference, and the works were got at £27,500.

Mr. *W. Burness*, examined by Mr. RICHARDS.

I am an iron-turner in Dundee, and vice-president of the Working Men's Association. After the bill was adjusted in Dundee myself and some of our members superintended a petition against the bill. That petition is signed by about 8000 persons. I know many of the names attached, and I believe they are those of ratepayers. I and some of my friends took signaturers. I gave directions to take no signatures but those of *bonâ fide* ratepayers, and to take neither the names of women nor boys. I have no reason to suppose that these instructions were disobeyed. The feeling of the working men in Dundee has undergone a considerable change since the bill was adjusted. I myself was partly in favour of it to a certain extent before the bill was adjusted, but after that I went directly against it. Those of my class who signed in favour of the bill generally did so because they had the impression that the commission was to be in the hands of the council. I know a number of sailors who signed the petition—my own brother for one. I heard Mr. Isdale's statement about two strangers signing, and thought it was a mistake. I have gone over the petition, and cannot find such to be the case. I think Mr. Isdale must have mistaken the petitions. I was not aware until I came to London that my children had signed.

The CHAIRMAN said the petitions were not before the committee, and therefore they need not go into that matter.

Cross-examined by Mr. DENISON: Until I heard of the commission I was in favour of the bill. Our association wished the magistrates and Town Council to be the commission. We objected to the minimum price of gas and the audit. We also thought the illuminating power should not be less than 20 candles. These points were settled to the satisfaction of the committee. I have heard since I came to London that there have been several alterations. The guarantee-rate, for instance, is a bad thing, and I object to that on the ground that we are assessed enough already. If the gas-works paid themselves the guarantee-rate might not come into operation; but they might not do so. Gas might be superseded, or the works might be blown up, when the expense would fall upon the ratepayers.

By the CHAIRMAN: I would prefer the council as the commission, because we would have power with them; but with the commission, as proposed, we would have none. The Working Men's Association would not be represented, unless through the council. We have no vote in the election of commissioners, because we do not occupy £10 houses.

Re-examined by Mr. RICHARDS: I believe one gas-work is sufficient for the community of Dundee. There is no necessity for two. We should like the price fixed most decidedly. If the Town Council were to purchase the

works instead of the commission, that would remove our objection. There are a number of working men in Dundee who do not burn gas; and upon them the assessment if made would also fall.

Mr. *J. Foggie*, examined by Mr. POPE.

I am a builder in Dundee, and am boxmaster to the wright trade, which is one of the three trades of Dundee. No one is admitted unless he is a practical tradesman. Any one is admitted into the nine trades on paying a fee, though he be not a tradesman at all. The three last senior magistrates were members of our incorporation. There are many of our members who are master builders, and hold a great deal of rateable property. At a special meeting called on the 31st of December, I proposed a resolution disapproving of the bill. We had sent round notices to the members, and there was a fair attendance. The resolutions, which were passed unanimously, represent the opinion of the incorporation, and very much the feeling of the community. We were anxious that the price should be fixed before any bill was promoted. Nobody should make a bargain until they know what they are to pay for it. I see no reason why the corporation should take the plant of the two companies, unless they get them at a price to justify such a proceeding. Arbitration would not meet my objection. I would like to know what we are going to pay for the works. So far as I have been able to judge, there has been a change of public opinion since this matter was begun to be discussed; and since the gas shares have risen there is a feeling that the community are to be "sold."

Cross-examined by Mr. DENISON: I could not tell you what object the Town Council could have in "selling" the community. The council have entered into an agreement, and they have an idea that they must carry it out. Our incorporation passed a resolution embodying their views, but they took no further action.

Mr. *R. Blackadder*, examined by Mr. RICHARDS.

In my capacity as valuer I had occasion to value the works of the gas companies. The old company have 90,000 yards of pipes, and the new 64,000 yards. The mains of both companies are in many of the streets. There are double mains in the principal streets. The area of ground occupied by the old company's works is something like $5\frac{3}{4}$ acres, and that occupied by the new about $3\frac{1}{4}$ acres. Much of the ground of the latter is unoccupied, and is available for the extension of works. There would be no difficulty in extending them to make them supply Dundee with gas.

G. Anderson, Esq., examined by Mr. POPE.

I am a gas engineer residing in London. I am well acquainted with the manufacture and supply of gas. I have known Dundee well for about twenty or thirty years. I have seen the gas-works generally, and have always understood that Dundee was well supplied both as to price and quality. I know most of what are called the seven towns. I think that the existing clause, by which the gas of Dundee is to be guided by the gas of the seven towns, is a very favourable one for Dundee. I think it is better than the Hume clause. There is no reason why the people of Dundee should not get good gas under this clause; it is their own fault if they do not. Some of the seven towns are more favourably situated than Dundee for obtaining coal, and that is one of the reasons why I say the average clause is better. In some of the towns there were also competing companies. I have heard nothing to convince me that the gas will not be much better supplied by the companies than according to the principles of this bill. You have legislation as a check upon the company, and you have an organized body to put that check into execution. If you put the works into the hands of a corporation, you remove the only organized check which exists. Corporations, I think, are the most inefficient bodies to conduct gas-works, and I disagree with the idea that corporations can make gas cheaper than gas companies. I do not think a commission formed as the one at Dundee is proposed to be, is likely to make an efficient body for superintending the supply of gas in that town. The members are liable to be removed from time to time, and from that fact they are not calculated to conduct the manufacturing business. I think it far better that the supply of a manufactured article should be in the hands of persons who understand their business, and have a direct interest in it.

Cross-examined by Mr. CLERK: I have been for several years the lessee of a good many works. I think the gas at Dundee at present is as cheap and good as could be expected. I am acting for gentlemen who are trying to oppose the introduction of this bill, and have had no communication with the gas companies. I contend that it would be much more difficult to ascertain the best gas in Scotland than to ascertain the average illuminating power of the seven towns. The people of Dundee, under Hume's clause, might go to twenty towns before they could find the gas better. In the one case you would only have to go to seven towns, whereas in the other you might have to go to seventy.

The CHAIRMAN said the committee had had sufficient evidence on that point.

Cross-examination continued: I believe it is better for the gas consumers to become shareholders in a gas company—and the more the better—than to have commissioners to manage their works. If I go to value gas-works for a purchase, I generally look at the profits the gas-works are making. If I were to look at them as a going concern, that would depend upon the condition of the reference. In this case I should do so. There was no parallel at all in the Weymouth case to this one. In this case I should give a certain number of years purchase upon the ascertained annual profit of the works. If a body owned gas-works which they were anxious to sell, I might look at the works, and give something upon the constructive value. I should simply give them a valuation upon the bricks and mortar. In a case of this kind, if I had been the purchaser, I should have employed some person to give a pretty close idea of what would be their value, and I should ascertain that by communication with the gas company. I should see, before I got very far into the matter, whether the sum required for them was or was not beyond my means. When people are willing to make a bargain, I think they ought to meet and form an opinion about what one would give and the other take, and, in case of disagreement, I would arbitrate; but I think it is unwise to arbitrate before you disagree. In this case there need be very little inspection of the works in coming to the price. The companies have been conducting their works at the present time, as far as I have heard, without any watch upon them, and no doubt the profits they are making would be some element in the arbitrator's mind in fixing the price. As that event has not taken place, they may possibly show a larger profit this year than the average; and, under these circumstances, I think the corporation have made a very loose bargain. I know that there is a letter scheduled to the bill, which says the arbitrator is not to take into consideration the exceptional circumstances caused by the legislation of last year, but that does not answer my point at all, because a large part of the expense of gas-works consists in repairs and renewals, and it is very likely that the renewals ordinarily done might not be done in a case of sale. I know a case in which the valuation was made upon the profits of one year only. It might not appear that there were less than the ordinary quantity of repairs done, and the arbitrator, in order to investigate the affair, must go to a vast deal of expense. He might ask for the books of the last three years, and he could then see whether the parties had made an exceptional profit on which to base their purchase. The companies are going to get a high price for the works, and they have been increasing their capital very recently, and will, I expect, get the whole of that put down as annuities. I do not think the increase of capital would affect the value of the gas-works, but it would the value of the undertaking to the seller. You have only to look at the circumstances which have taken place in Dundee to show that it is the settled opinion. I should hold the same view myself if I was engaged in a company where perhaps one-fourth of the capital was in borrowed money, upon which we were only receiving a small rate of interest. If I found, by some agreement with a person I was going to sell to, that I was likely to get a good price, and had the power of capitalizing, I would show to the arbitrator that the profits made in former years were not so large as would be made in future.

By the COMMITTEE: I do not think the prospect of better security from the guarantee-rate would have the effect of increasing the price of the shares so much as the certainty people will feel about fluctuation. Companies pay from 8 down to 2 per cent.; but the annuities will be permanent.

Cross-examination resumed: Arbitrators often give 20 years purchase, and sometimes more than that. I think the shareholders for the time being will benefit by the £50,000 mortgage debt being converted into share capital. I do not conceive it is at all absolutely necessary that the valuator should confine himself to the last three years profits. There might be prospective advantages such as a new district rising up, which they had been building works for, and which they were to get a large profit from in the future, and that would be an element in increasing his price. The persons who would suffer would be those who had to pay. There is a certain amount ascertained for the value of the works, and it does not signify a button among how many persons it is divided.

Re-examined by Mr. RICHARDS: I am aware that while the company owed £50,000 the annual charge upon it was 4 or 5 per cent.; but that now it is capitalized they regard it as entitled to 7 per cent. I do not think there is much doubt that the companies will be able to pay the highest parliamentary dividend. There is no doubt the companies know what they are about better than the corporation. I have understood that the corporation know neither the profit nor debt of the gas companies. If the net profit could be arrived at, and the number of years purchase, there would be no difficulty in putting these into the schedule. I know a case in which that was done, but in arriving at the profits the superintending agent had to assist in seeing the business carried on for a year, so that nothing might be done that was irregular, and by having a check they had confidence in the net proceeds of the year.

Thomas G. Barlow, Esq., examined by Mr. RICHARDS.

I am a civil and consulting engineer, residing in London, and for more than 40 years have had considerable experience in the erection and management of gas-works. I have also acted as valuer and arbitrator for the sale and purchase of gas-works in numerous cases, both for companies and commissioners. It is the usual habit to value gas-works at a certain number of years purchase—20 years usually in the case of incorporated companies, subject to deduction for dilapidations, and increase for unexhausted power of production in the works. I have known 22 years to be given. Compulsory purchase would be an element to be considered in addition to the 20 years. In this case it is left to the arbitrator to decide whether it is to be a compulsory sale or otherwise. If the divisible receipts are limited by Act of Parliament, and the actual profits exceed that limit, I should take the sum under the parliamentary powers—because, if the profits have been large, it shows there has been an excessive price charged, which the vendors must not take into consideration. If the divisible profits are not limited the actual profits must be taken. The old company in Dundee have issued 1250 shares, upon which £23 10s. has been called up. I am aware that upon that they have recently paid £3 per share, which comes to $12\frac{1}{2}$ or 13 per cent. I am also aware that since the Act of 1867 they have issued £50,000 of new capital for paying off borrowed money, which is limited to 7 per cent. Supposing the company, who now pay 13 per cent. upon the old shares, be sufficiently flourishing to pay 7 per cent. upon the new £50,000 instead of the 5 per cent. formerly paid, the total annual charge will be £7250. The arbitrator might take a larger basis than that, because there is no limit upon the original capital. If it were shown that the net profits of the undertaking exceeded £7250, he would carry the surplus to the credit of the old capital. The new company have a paid-up capital of £40,000, upon which their dividends are limited to 10 per cent.; £15,000 is, under their new power, limited to 7 per cent. The sum total they could pay upon those two would be £5050 per annum. If those two items are multiplied by 20 you get the sum of £246,000, plus whatever unexhausted plant they may have which has not been brought into profitable use. If the arbitrator should be of opinion that the sale should be compulsory, there would be something added—we usually take it at 10 per cent. I can scarcely form an opinion as to whether the commissioners have any real notion of the liabilities they are undertaking. The great majority of the witnesses seem to have thought they were buying the works, yet what they are actually buying under the agreement and bill is the "undertaking," and the two are perfectly distinct. There is no necessity for the word "business" to be used; "undertaking" is sufficiently large to cover the business. I do not consider the bargain a good one for the inhabitants, but it is for the gas companies, as it enables them to realize the present market value of their property upon the best possible terms. The public take the risk of any new invention arising that might supersede gas and render the works of no value. Experiments have been, to a certain extent, successfully made, by which hydrogen gas may be burned in combination with oxygen very successfully. It is true that the cost of producing oxygen is yet rather heavy; but still, it is not impossible that other materials may be discovered by which its cost may be reduced. I do not think anything is likely to be done with water gas, as the cost of decomposing steam into hydrogen gas is greater than the cost of coal gas already manufactured. Ingenious attempts have been made in France, by making hydrogen gas pass over the spirit of naphtha, or over richer gases produced from coals, but they have failed from the cost of decomposing the vapour. There was also a process for carburetting atmospheric air about 30 years ago, which was partly successful, and much affected the value of gas property at the period. It is proposed by this bill to take a sinking-fund in addition to the assessment of the guarantee of the annuities, which will go to augment the price of gas. As it now stands, the consumer only pays what is necessary for the interest or dividends of the gas companies; but if you create a sinking-fund in addition, that can only be done by increasing the price of gas. From the bill as drawn, all extensions and enlargements must come out of the revenue. There is no power of borrowing money beyond £30,000; and as gas-works generally increase from 10 to 15 per cent. per annum, a large expenditure will be required for extensions, and they must come out of profits. A fluctuating body of

commissioners is the worst that can be devised for the management of gas-works. I have seen many instances of the manner in which it has worked, and am satisfied on that point. When gas-works get into the hands of a public body there is no chance of competition taking place; and the liability to competition is one of the strongest levers to keep gas companies in order. An instance occurred two years ago, in Brighton, where there are two companies. One of them gave a large bonus to the shareholders, which roused the inhabitants, and they formed a third company, and subscribed sufficient capital to carry a bill through Parliament. The old companies immediately came down to the prices and the quality proposed by the new company, and the new Act has remained a dead letter, because there is no inducement to build new works, as the old companies have done all that was required. I am familiar with everything connected with Manchester for the last 20 years. The Police Commissioners first established gas-works there. In 1848 the works were transferred to the corporation. A portion of the profits of those works have been from time to time applied in increasing the plant and extending the capital. The mortgage debt is £312,000, and £816,900 has been actually expended upon those works. In addition to that, since 1840 the sum of £490,000 has been expended in improvements. During the first years of the accounts I have before me they overcharged the consumers. While Liverpool was having its gas at 4s. 6d., Manchester was charged 6s.; that addition of 1s. 6d., of course, formed a large sum. Liverpool is supplied by a company. The price at Manchester has always been more than at Liverpool until this year. The Liverpool Company has been supplying at a price which has been found insufficient to pay their statutory dividend, and they have had to raise their price to 3s. 3d. The Manchester system is not one I should recommend, and it is not to be adopted here. I should say that the effect of the reduction in price in Manchester has been to reduce their surplus profits from £60,000 to £13,000 a year. The price at present is 3s. 2d., except to consumers of more than half a million feet in a quarter, who have a reduction of 1d. The works at Paisley were bought by the corporation on the basis of an annuity of 6½ per cent. for each £100 of share capital, which annuity was fixed in the bill. There is no security beyond that, and no power of assessment. There are two or three instances of the amount of annuities to be paid for the works being left to future arbitration, but in the great bulk of instances it is not so. I have here 20 bills, and only one case among them—that of Aberavon, which has since been purchased for £2241. I know something of the ingenuity displayed in making up claims for compensation under the Lands Clauses Consolidation Act, and I should much prefer seeing the amount fixed than leaving it to the contingency of such a tribunal. In the Weymouth case the valuations on one side were about £16,000, and on the other £55,000; but there were some peculiarities in that case as to the higher claim which would not apply to Dundee. I never met an instance before where the arbitrator was left to determine whether there was to be a voluntary or compulsory purchase. The price to be paid here is left, of course, to whatever they can substantiate before the arbitrator. I have a number of Acts here, and I find generally that wherever a sale is imperative, and not merely permissive, the price is fixed in the Act. Where the sale is simply permissive, agreement is allowed; but I do not know that arbitration is allowed. [Witness handed in an analysis of the various Acts.] The circumstances under which the two Glasgow Water-Works were conveyed to the Town Council were these: there had been great complaints as to the quality of the water, of the inefficient supply, and the high charges, and the Town Council undertook to remedy these complaints by getting water from a new source—Loch Katrine. One company agreed to sell, and the terms were fixed by the 17th section of the Act. The Glasgow Water Company refused to sell, and the terms were settled by arbitration under the Companies Clauses Act. There are two powers of rating—one the domestic water-rate of 9d. in the pound, and the other a public rate of 1d. in the pound, which is merely supposed to pay the expense of watering the roads and putting out fires. There is a case within my knowledge in which a public body proposed to take possession of the gas-works, the price not being fixed, with the power of raising an unlimited assessment for a rate in aid—that of Spalding, in Lincolnshire—but that was a permissive power, which they were to exercise within ten years. In that it differs from the Dundee case. I find in the Spalding Act a maximum price was fixed for the gas; but there is no provision in this case, either as to the maximum price, the purity, or the quality of the gas. There is nothing to prevent the commissioners poisoning the inhabitants with impure gas. Those powers are invariably introduced into every gas Act of the present day.

By the COMMITTEE: There is a maximum illuminating power of 18 candles in the bill, but they are actually getting 28 or 30.

Cross-examined by Mr. DENISON: In some cases I have been umpire, and in others one of the arbitrators. My own practice has been usually to take 20 years value of the net profits of a company with statutory powers, subject to variations in particular cases. In taking the annuities we take the net profits. Supposing the Dundee old company had a profit of £7250 a year, and you gave them 1250 annuities of £3 each, that would represent an amount of £5000. I give the annuities exactly corresponding to the net profits, and no more, except there are unexhausted works. On the other hand, there are dilapidations to take into account; and assuming those things balance each other, the net profits are given as a perpetual annuity.

Mr. DENISON: Then all the calculation about the net profit has nothing to do with it. They are figures to talk of, but not what will be given or paid?

Witness: No; I put it in that form that the parties promoting this bill might see what charges were upon the property.

Cross-examination continued: As arbitrator I have had evidence given before me that estimating the structural value was the proper mode to adopt, but I did not act upon that. In the Weymouth case, where the arbitrators disagreed, the amount ultimately awarded was £26,350. I was on the part of the vendors, but I was no party to making the claim of £55,000. It was an exaggerated claim, and I could not for a moment uphold it. We looked upon it the more suspiciously because every book upon which that claim was founded had been intentionally burned. I think that in Dundee matters should be left as they are; the works should be in the hands of the gas companies. I am not aware that is an opinion from which Parliament is getting rather to dissent. I am not aware that Parliament has of late put in powers of compulsory purchase. I was not engaged in the Windsor Water Bill, but I think the committee fixed a maximum annual profit of 10 per cent. above what they were then earning in that bill. I do not object to a sinking-fund, but I object to its coming out of the consumers pockets. Every gas company in England and Scotland is authorized under the Gas Clauses Act to have a sinking-fund up to one-tenth of their capital, and then it stops. The sinking-fund in this bill is £1000 a year, and the annuities have to be paid in addition to it. It would take something like 300 years to pay off the annuities. In ordinary cases they cannot pay off any proportion of their capital out of the sinking-fund; it is only used to equalize the dividends and pay for any unforeseen or extraordinary accidents. There is no provision in this bill, as I read it, for making extensions; they must be paid for out of profits, or else by the corporation coming to Parliament from time to time for authority to borrow money for that purpose. I am not aware that is a common practice for corporations, although companies do so. I should prefer that corporations did come to Parliament from time to time, as it would afford an opportunity of revising the legislation on the subject, as it might be shown that the commissioners had mismanaged the undertakings.

Mr. DENISON: Supposing I want to spend £50,000 in new works, show me how I can do it by this bill, seeing that I must reduce the price from year to year to make the profits fit the expenses.

Witness: Supposing you increase the price. If you extend your works without the necessary funds to pay for them, you may get those funds by raising the price of the gas. A gas-work generally increases 10 or 12 per cent. yearly in its consuming power, and taking the smaller company of Dundee—the new company—with £50,000 new capital, perhaps £3000 or £4000 a year might be expended. As the bill stands that sum must come out of the profits; and if the money is borrowed, the interest must come out of the profits.

Mr. DENISON: Then the gas consumer must pay either way?

Witness: Yes; but I have put it that he pays the capital.

Mr. DENISON: But he gets the profit of it next year?

Witness: No; not so happily as that.

Mr. DENISON: Why should it not come directly out of the profits of the year instead of indirectly?

Witness: By taking it directly out of the profits you make the consumer pay the whole capital off at once. If the money is borrowed, the consumer pays the interest upon that money, then, of course, the consumer of the day is only taxed with his fair share. I think there ought to be power given to the commissioners to raise more money than the £30,000 proposed to be raised. I do not know that the borrowing powers of this bill were originally twice as much as now. If that was the case, I suppose there must have been some reason for reducing it. I did not know that the people of Dundee objected, but I should say the people did not understand the extent of the obligations they were contracting.

Re-examined by Mr. RICHARDS: In water-works you get 25 years purchase.

By Mr. BONHAM-CARTER: Of course the variations in the price of gas, and various other causes, would influence, to some extent, the arbitrator. If you find a company in bad odour with its consumers, and threats of rival companies getting up, that would influence the arbitrator to some extent; but, on the contrary, if you find the company well established, and nobody inclined to find fault, and the prospects good, the value of the shares would, to some extent, be taken into consideration. You would take the market value of the day.

FRIDAY, MAY 29.

Mr. RICHARDS said it became his duty to offer some remarks on behalf of those whom he represented—namely, the Chamber of Commerce and certain traders, inhabitants, ratepayers, and others of Dundee. Some questions had been asked from time to time as to who and what the Chamber of Commerce were, and the position they occupied. He thought, after the evidence the committee had heard, there was little doubt that they contrasted in position with any body or association of persons existing in Dundee. Far be it from him to draw anything like invidious distinctions between the Chamber of Commerce and the Town Council of Dundee; he simply said that, if the Town Council were all men of substance, all honourable men, he thought his clients were at least as much entitled to consideration in regard to the views they entertained. He was afraid that Dundee, like some other towns, was suffering from the fact that the persons most competent to conduct their business—most likely to give importance and weight to the Town Council—were withdrawing themselves from the Town Council of Dundee, just as they did in the metropolitan vestries. A point had been raised as to the consistency in opposition which the Chamber of Commerce had exhibited. He could not help thinking that when the constitution of that body, which was unlike a private individual, but who had to be called together from time to time, was considered, the committee would say that their conduct had been consistent in the opposition to this bill so soon as they understood what the features of the bill were. One could not help feeling that when two bodies like the Chamber of Commerce on the one hand, and the Town Council on the other, entertained conflicting views, neither party could have very much difficulty in getting up petitions, so he would put them on one side, and only say that it gave the opportunity for seeing some of the most intelligent working men in the box. The Chamber of Commerce said that this bill was unnecessary because Dundee had been lighted by two companies, whose competition was a sufficient safeguard, and the inhabitants, they thought, ought not to be committed to the risk of a trade speculation with the view of supplanting those companies by a corporation. [The learned counsel gave the history of the companies and the agreement.] That agreement had undoubtedly had the effect of putting a stop to competition in one sense—it had put a stop to reckless competition—it had put a stop to that mutual animosity between the two companies which almost invariably led to destructive and wasteful expenditure, which destructive and wasteful expenditure, sooner or later, invariably had to be made good by the public. It had put a stop to the excessive nuisance of the double opening of streets, to the double search for escapes; for when escapes took place, each company laid the blame upon the other, and repudiated the liability to search for them. It had put a stop to the double expenditure of capital, and therefore has been economical in that respect, as preventing there being two capitals upon which interest had to be paid. But he did say most emphatically that competition had been substantially preserved. The power which the Town Council or the commissioners of police had to step in and purchase the new company had been a moral force, acting not only upon the new company, but also upon the old company, against whom, if they purchased the new company, they would come in as competitors. That clause was no dead letter. The committee had heard, though they had not gone into the question, that a certain thing called the Dundee Gas Bill, No. 2, was upon their list. He (Mr. Richards) had a strong impression that it would be found that the Dundee Gas Bill, No. 2, was, in fact, a bill founded upon the 52nd section; but so afraid were the Town Council that the companies should give them the slip, that they had got this Dundee Gas Bill, No. 2, in order to be able to pounce down upon the companies, supposing that they at a Wharncliffe meeting should repudiate this agreement. With regard to the question of lighting, it was a very remarkable thing that, from the first to the last of this inquiry, no living soul connected with the gas companies had ever been called. There had been no difficulty in calling them; they were all in the room. His (Mr. Richards) object had been to

raise all the difficulties he could about their financial condition, in order that he might, if possible, force some of these gas people into the box; but although the gas people were all in the room, and although the gas secretary had been standing there throughout the whole of this inquiry, they had never put a single man representing the gas companies into the box. He did not care whether the gas was good or bad in Dundee. He would take it either way. Either the gas was good at present, and they had no cause to complain; or if the gas were bad, the Town Council of Dundee were grossly neglecting their duty in not having it improved. They had now what they never had before under Mr. Hume's clause—a certain, clear, ascertainable standard. They had the power of enforcing penalties with the greatest possible facility under the last Act of 1867. Why had they not done so? Were the Town Council of Dundee people likely to neglect their duty in such a matter? He would tell the committee why they had not done so. It suited them at the present moment to raise the cry of bad gas, and so raise a sort of odium and bring an additional pressure in favour of the bill. Another material element was, had they any cause to complain as to the price? Provost Hay said there had been an enormous rise—10 or 12 per cent. What had been the rise? 2d. per 1000 feet, and that was since this agreement had been made. The price was regulated by an easily ascertainable standard—the average of seven towns; and the committee would find that if the gas at Dundee had risen 2d., it had been raised less than it might have been, by taking that average standard of the seven towns. Was there any incapacity in the works? Was there any prospect that, as time went on, they would be unable to extend their works to meet the requirements of the town? They had the evidence of Mr. Blackadder, the valuator, familiar with every part of Dundee, and he mentioned exactly the space they had, and said there was no insufficiency of ground. He would do his learned friends the justice to say that they never alleged anything of the sort, so that the committee had got those three matters—rating, price, and power of extending the works; and those three things, coupled with the fact that they had moral competition now existing, showed that so far as public necessity went there was no need for transferring those works either to the Town Council or to a body of commissioners. A good deal had been said by the Town Council with reference to the disadvantages they were under by losing Mr. Hume's clause, and having substituted for it the average of seven towns, with the minimum of 18 candles. [The learned counsel went on to argue that Hume's clause could not be enforced, and quoted from the evidence.] The community were being forced into a trade speculation, for they were being placed in a position where they would have to buy a double plant. His learned friend said there was no risk. He did not say he apprehended that gas was about to be immediately superseded; but there was a risk attending gas companies—there was a risk attending the trade, and he was content to say that the risk was measured by the greater weight of interest which a purchaser in open market could obtain for money invested in gas compared with what he could get for water or railway shares. He should possibly be told that all that risk was to be considered by the arbitrator in determining the value of the annuities. His learned friend put that to Mr. Barlow—"There is this sort of risk; but do you estimate that as anything tangible in valuing gas-works for transfer?" "Well," said Mr. Barlow, "if I do, at all events it is estimated in the 20 years purchase." Therefore, as regarded that risk, it might be taken that the probable basis of valuation would be what Mr. Barlow and Mr. Heron both pointed out—namely, so many years purchase of the net profits of the concern. Having dwelt on the rise in the price of the shares as showing the large price which would have to be paid, the learned counsel said he would pass to the details of the manner in which that transfer was proposed to be carried into effect. His clients objected to it, because in the proposed transfer there was no maximum price fixed for the works, but it was left entirely open for the arbitrator to value it at his option, whether it be a compulsory or voluntary sale. One of the points which from the first the Chamber of Commerce had most earnestly pressed was that no price for that transfer had been fixed. What must strongly strike every man of sense was that the price to be paid for a thing, or at all events an outside price, a price which was not to be exceeded, ought to be distinctly stated before they bound themselves to meet the price in the way proposed here. Was there any difficulty in doing so? Mr. Heron stated that the ordinary mode was to take so many years purchase of the net profits; and Mr. Barlow said the same. If that were so, what real difficulty would there have been in ascertaining what the profits of the companies were at the time the bargain was made? They have merely to ascertain that and multiply it by 20 or 22 years, and the thing was at once ascertained. Another question which materially affected the value to be given was whether the sale should be compulsory or voluntary. He (Mr. Denison) thought he could see how the matter stood. The Town Council of Dundee, when this agreement was first made, thought they were going to buy the works at their structural value, and that they were going upon the basis of a voluntary sale. [The learned counsel quoted from the evidence.] But the gas companies had throughout taken another view. The bill was drafted by the Town Council, in conformity with their view; and the clauses introduced had been introduced at the instigation of the gas companies, who said, "Put in the very words of the agreement." According to Mr. Barlow, the word "compulsory" added about 10 per cent. to the price, so that that was another element of uncertainty about what they have undertaken to do. Something had been said of the approval that the public had shown of this measure, but had the public ever appreciated the measure? Had the public ever been informed of the various changes and modifications the bill had undergone? Did the public know that they are to buy, not the structural value of the works, but a going concern with its goodwill? Had the public ever been informed of that? They were told that the thing had been published in the newspapers. It was idle to talk of the public in Dundee taking notice of changes in the bill from the reports in the newspapers. The public had never assented to the bill in its present state. Then there came another question, as to the annuities, and the basis upon which those annuities were to be established. He (Mr. Richards) complained that, while annuities in the bill as drafted were to be corresponding to the "fair value of the works," it was now provided that they should be according to the share capital as at the 11th of November next. In regard to another thing—the interpretation clause—so determined were the companies that the word "undertaking" should include the goodwill of a going concern, that they had got the word "business" included. Was that ever submitted to the public of Dundee? Did they ever approve of it? With reference to the issue of new stock by the companies, by the conversion of the debt, the learned counsel said the directors had done just as he should have done—they had "shoved" every farthing they could into the capital of the concern, to the disadvantage of the people of Dundee, who would have to pay for it.

Mr. BONHAM-CARTER asked the learned counsel how he argued that, the shares being increased in value in the market—that was to say, from £51 to £63—would affect the price at which the annuities are to be assessed.

The CHAIRMAN: Such price depending upon the net profits.

Mr. RICHARDS had never said it did. The arbitrator need never look at the share list—he might look to the same circumstances which the people in Dundee had looked to, and he might say, looking at the enhanced value of this property on the 11th of December, "I must give a much handsomer price than I should have done at an earlier period." The council ought to have made the bargain, and not have allowed the directors to invest a large amount of capital in the interval at 7 per cent. With regard to the debts, why had they not been told distinctly what the debts were? If they owed nothing, why had not that been proved? The debts ought to have been scheduled before they were asked to take a leap in the dark. In respect to the annuities, it was unreasonable and improper that the shareholders should take an absolute certainty while they were relieved from all risks hitherto incident to the trade. That was against the first principles of justice. Again, if the companies were to be paid at all, payment by annuities was a ridiculously costly way of doing it. It should be done by a lump sum down. Why could not the Town Council do it? Their credit was good. They had a balance in hand. They could borrow half a million if necessary, at something like 4 per cent. Referring to Paisley and Glasgow, the learned counsel said there was no gas-rate in Paisley, and in Glasgow the taking of the water was an absolute necessity. With regard to the question of whether the assessments were limited or unlimited, he (Mr. Richards) thought it was equally objectionable either way. He entirely objected to an assessment of any kind, particularly to a limited one; for he thought that the moment a limited assessment was allowed to be made the parties would probably come again, and make that a fair ground for an increase of the assessment in another year. He would only say, with regard to one other point, that some of his witnesses had shown no great indisposition to the transfer, particularly those who were called latterly. But they objected in this way. They said, "If you must transfer it to anybody, transfer it to the Town Council, and not to these commissioners. In the hands of the Town Council their credit is good and ascertained; but the commissioners are a numerous body, and we know how they are to be elected. They are a sort of body representing all classes." Having thus endeavoured to establish these facts, he hoped the committee would come to the conclusion of certain thinking sensible men in Dundee, who thought the bill stood a fair chance of being knocked over.

Mr. DENISON, in replying upon the whole case, said his learned friend had represented the Chamber of Commerce to be an important body in Dundee, and no doubt they were so; but his friend forgot that the chamber was only one of sundry bodies in Dundee; that it was the only public body which appeared in hostility to the present bill—although there were certain individuals belonging to other bodies who expressed their own opinions—and that of the 150 members only 47 were at the meeting, of which 47 an unknown number had departed before the resolution had been agreed to. His learned friend had brought forward the Chamber of Commerce as the reason why the committee should not pass the bill; but it would be strange if the bill should be rejected because a small minority in a small body in a large town were against it. There was no doubt that a great number of the signatures to both petitions were what all would agree in calling rubbish. He (Mr. Denison) put them on one side, but he would mention that while his clients petition had about 15,000 signatures, his friend's petition had only about 8000; so that, from any point of view, the committee must come to the conclusion that the majority of the ratepayers were favourable to the passing of the bill; and he would also say the majority of the Chamber of Commerce, because 100 more than the 47 might be agreeing to the bill. His learned friend spoke of people not reading about the agreement in the newspapers, but that was most unlikely. It must have been perfectly notorious in Dundee that that bargain was made in March, and that the Town Council were all but unanimous in favour of it; and there was no opposition disclosed to it until that slight opposition in the Chamber of Commerce in October, 1867. But his learned friend was pleased to say also—speaking offhand, and not from what was in the evidence—that the best people in Dundee did not belong to the Town Council; but he (Mr. Denison) knew to the contrary. The next point was this: his learned friend had said the bill was unnecessary, and the competition which existed was a sufficient safeguard. He (Mr. Denison) would not refer to any of his witnesses to answer that; but when Mr. Sturrock, the secretary of the Chamber of Commerce, was asked, at the commencement of his cross-examination, whether the two companies were in a state of combination or competition, that gentleman admitted, after some time, that they were in a state of combination. Not merely had the companies been working under the agreement made for them by Mr. Kerr, but those two companies had actually been worked by one manager—a manager who had been changed lately as an individual, but always by one manager since 1855. It had been said by a witness that one of the objections to the plan was, that the corporation were going to buy two works where one work would do. It was put to him, "Do you suggest that two works are too large, and that any part of them has been thown out of action?" but he could not say that was the case; and therefore that was the best answer that could be given to the statement that those works were unnecessary—viz., that they had been worked together, and, of course, each utilized as well as it could be, and nothing done in duplication; and it was rather a striking piece of information on the part of Mr. Don, that probably a third company might be necessary before long. His learned friend then passed on to remark that no gas director had been called, although they had all been present, and said it could not be suggested that he might have called them, because they were hostile to him. But why could he not have called them? It had been done in the House of Lords not long ago in the Cambrian Company's bill. And why could not his learned friend have done the same? Because he did not choose. He preferred the common *nisi prius* trick of saying, "Gentlemen of the jury, they have not called these witnesses. What can you think of gentlemen who have not called such witnesses?" The accounts of the companies could have been handed to one of the witnesses, who might have been examined upon them; but it suited his learned friend better to have a grievance, and to say that not a witness had been called to prove the accounts; but the arbitrator who was to decide everything that had to be decided must have those accounts. He (Mr. Denison) was now going possibly to astonish his learned friend, and it might be to astonish the committee. His learned friend had brought up as his great witness—and he was a very good witness and a very straightforward man, and there was not a word to say against him—Mr. Barlow. Now, he had not the least objection to let Mr. Barlow be named as the arbitrator. The gas companies had been communicated with, and he was authorized to say they would even consent to that; and if they consented—and the committee know that scientific witnesses were almost as much advocates as counsel—Mr. Barlow should be the arbitrator if Mr. Richards chose it to be so.

The CHAIRMAN (to Mr. Richards): You are not authorized to give any answer.

Mr. RICHARDS: Mr. Barlow has estimated the price at £300,000.

Mr. DENISON: £246,000.

Mr. RICHARDS: £246,000, with 10 per cent. added if there is a compulsory sale.

Mr. DENISON said of that he was to be judge. He would now deal with that question of compulsory sale. As it stood at present the bill left it open; but once throw out Mr. Lloyd's alteration, and the arbitrator consented to by all the three parties, and the whole consideration for a voluntary assessment came to an end; the companies would then, no doubt, be entitled to insist upon compulsory purchase, and he was there for the corporation begging the committee not to do anything of the kind. The companies wanted to get the concern sold upon the best possible terms, and the corporation wanted to keep out of the 10 per cent. for compulsory purchase; and the best way to keep out was to stick close to the bill as settled by Mr. Lloyd. One of the witnesses talked about the people of Dundee being "sold," and he was asked what interest the commissioners could have in "selling" the community. The Town Council represented the people of Dundee more distinctly and positively than anybody else; and undoubtedly they had the clearest and strongest interest in getting the agreement confirmed. Under Mr. Hume's clause, they need only get some town which produced better gas than Dundee, and immediately they were entitled to have the same quality. They were not bound to prove it was the best in Scotland. In the other case they had to get the average of seven towns, and prove it before some court as they could; and although his learned friend might say Mr. Kerr could get it, the moment he tried to put that before an arbitrator he would be laughed to scorn, and told by the parties—"You do not suppose we are going to enforce the clause upon a parcel of town-clerks letters." Then, under Mr. Hume's clause, they said there was no penalty; but there was something better than a penalty, because there was the provision that, if the gas was not equal to the standard, the party might refuse to pay for it. The next thing his learned friend dwelt upon was the risk. He said he did not think there was much in the risk himself, but still it ought to be allowed for. Mr. Barlow did allow for it. In valuing water companies which had no risks, he gave 25 years, and in gas companies 20 years purchase; and although the present matter was not to be settled on the principle of so many years purchase, it was just as easy to take off one-fifth of the annuities as to take five years from the 25. Then his learned friend went on to say, that the shareholders of the companies were very glad of the bill, and that the rise of shares proved it. He (Mr. Denison) was not sure of that, and perhaps he knew more about it than his learned friend did. He knew this, that unless the bill had been adjusted in the shape in which it was now it would not have been allowed to pass. With regard to the rise in the price of shares, it was true that the directors had been buying the shares, and at an advanced price; but why? One of two things would happen—either this bill would pass or it would not. If it passed, then they would have fixed annuities, secured by a guaranteed rate, instead of an income depending upon the risk of trade; and everybody knew that guaranteed shares and debenture stock sold for about one-fifth more in the market than precarious shares in any kind of company. Then there was the other alternative—that the bill did not pass—and then what would happen? They had got all the advantages of last year's legislation to depend upon. They had got the £50,000 limited to 7 per cent., if they could get it; and the old £30,000 was unlimited; and the new company had also a capital, which they got by their money bill, upon which the agreement was made, as a consideration for the withdrawal of the opposition of the corporation, and the consent of the company to the purchase of their works. So that in either alternative there seemed to be the very best reason why the shares should have risen in price; and he had no doubt the directors had bought such shares as came into the market. In dealing with the question of capital he was sorry to have to dispose of the beautiful fallacy which his learned friend had fallen into. His friend's proposition was that, because the company got power to take the £50,000 last year, and converted their debt into shares, as the committee probably knew, under the provisions of the Companies Clauses Act, and did a thing which the Legislature encouraged rather than the contrary, upon the valuation of those works the 7 per cent. would have to be taken into account. If they would wait until the company were earning 7 per cent. on the new capital, that would be so—and that was why the promoters were so anxious to catch the thing in its infancy; but that period had not yet arrived. According to Mr. Barlow's evidence, the capital had nothing to do with it. If Mr. Barlow was adopted as arbitrator, he would give them 20 years purchase, not upon the dividends, but upon the profits.

The CHAIRMAN: But was not the interest of £50,000, while it was a debt, deducted from the profits?

Mr. DENISON said Mr. Kerr had put it as a deduction of 4½ per cent. The whole concern was divided into what might be called debenture-holders and shareholders, the former holding £50,000 and the latter £30,000. So long as the debenture-holders only received 4½ per cent. it was so much the better for the shareholders; but the moment the debenture-holders were raised into shareholders they were also raised to 7 per cent., and then so much the worse for the other party. The arbitrator had nothing to do with that; he merely took the total receipts, and deducted the working expenses. With regard to the objection to the word "business" being inserted in the bill, having said that the word "undertaking" ought to mean business as a going concern, did his learned friend mean to say that he ought to take the chance of its not being so before the arbitrator, and that he ought to cheat the companies out of their price for his business? It had been said (not merely by gentlemen of Mr. Barlow's experience, but even hot and burning partisans like Mr. Malcolm) that it ought to be valued as a going concern; but now the word "business" was objected to in the clause. He (Mr. Denison) saw they were going to raise an agitation against the arbitrator valuing it as a going concern; and the more noise they made about its being put in the more he saw that Mr. Lloyd was right in putting it in. Another point made by his learned friend and by his witnesses, as a complaint against this bill, was that the date of valuation was improperly fixed; but the date was not fixed by the bill—it was fixed by the agreement; and what business had they to substitute a new date?

The CHAIRMAN: I do not see that the date of valuation is fixed by the agreement.

Mr. DENISON: The date of entry is fixed.

The CHAIRMAN: It does not say that the date of valuation is to be the same as the date of entry.

Mr. DENISON said if that were so he did not think the bill did. But he was taking it at the worst, according to his learned friend's assumption, that the arbitrator would view it according to the date of entry. All that he was concerned in pointing out was that the bill did not go in that respect beyond the agreement. It must be evident to everybody that there must be some time fixed from which the capital was to be reckoned. The principle was in the breast of the arbitrator. The agreement was governed as respected price, quality, and other advantages, by the letter which was scheduled to the bill. His learned friend also talked about the debts not being inserted, but that was included in the remarks made about the agreement. It must be perfectly well known what the debts were—indeed, there were no debts of the old company, because they had been all disposed of by the Act of last year; and with regard to the new company it was as notorious as anything in Dundee what the debts were. At any rate, the arbitrator would ascertain; and, if the debts turned out more than were expected at present, so much the worse for the shareholders, for when the arbitrator gave them their annuities he would make a deduction from them. About the guarantee-rate there still seemed to be some complaints, and it was quite true there were other towns in which there were no guarantee-rates; but he (Mr. Denison) would be glad to know if those other towns were limited as to price in the way Dundee was. The scope of the agreement was that the promoters were never to charge any higher price than would just pay the expenses. He should be glad to know what man in his senses would take a rent to be fixed in that way without profits. They were to keep their rent down, so that they could earn no margin, and therefore they required the aid of the guarantee-rate to guard them against risk. To listen to the proposition on the other side would be equivalent to throwing out the bill, because it was perfectly evident that no man in his senses would take such an annuity as that. His learned friend said that if the Town Council were the purchasers there would be no need of a guarantee-rate. That was the case, because all the funds that could be raised by rates would become liable without special legislation; but if, in order to secure the representation of all classes, it was necessary to have commissioners, who had no public property—instead of the Town Council, who had a public power of rating—the gap must be filled up by giving them a rate in aid; a power the probability of which being used everybody said would be extremely small, and as to which his learned friend said he did not care whether it was unlimited or not.

Mr. RICHARDS: I say it is equally objectionable either way.

Mr. DENISON: Thank you. With that remark, then, I will sit down.

The room was then cleared. On the parties being readmitted,

The CHAIRMAN said the committee were prepared to pass the preamble of the bill, but there were certain matters connected with the clauses which required amendment. First, the committee would require a clause inserted to meet the objections of the Board of Trade.

Mr. DENISON said he had no objection to that.

The CHAIRMAN said the clauses relating to the payment and transfer of debts were not satisfactory.

Mr. DENISON: Have you not had a new schedule given in?

Mr. BONHAM-CARTER said it only professed to show the debts of the new company.

Mr. DENISON: We proved there were none of the old company.

Mr. RICHARDS: It was asserted, but not proved.

The CHAIRMAN said in the next place the committee thought six weeks ample him to find the debts out, and anything which might emerge after that should be treated according to the law of the land. But the most important part of all was that clause 21A—the scheduled letter—was not sufficiently clear in its instructions to the arbitrator. Assuming that the valuation was to be based upon the average of the annual net profits for a term of years, the committee were disposed to limit the time over which such calculations should extend to the date of the agreement, the 8th of March, 1867.

Mr. DENISON said that would require some modification, because the returns had been altered since then. The annuities were to be determined upon the annual net profits of the companies taken as a whole, but the subdivision of the capital among the debenture-holders and the shareholders had been altered since that time, and therefore that would involve another alteration.

The CHAIRMAN: The amount is the same.

Mr. BONHAM-CARTER said clause 25B would settle the amount of the share capital.

Mr. DENISON: You do not mean to cut off the new stock issued.

Mr. BONHAM-CARTER: No; this clause entirely reserves the condition of the capital in the arbitration to its present state.

After some further conversation,

The CHAIRMAN said all he had done was to announce the preamble proved, and they would now proceed with the clauses.

On clause 7,

Mr. RICHARDS said his clients wished, if there was to be any board at all, to have the magistrates and Town Council of Dundee as commissioners.

Mr. DENISON said he would not argue that question, which was contained in the preamble.

The CHAIRMAN said the committee had considered the matter, and had agreed to adopt the clause.

On clause 20,

Mr. RICHARDS said the clause professed to relate to an auditor appointed by the commissioners, but it did not appear that sufficient power was given to any consumer of gas interested in disputing the matter to appear before the auditor and argue the case. He would therefore propose an amendment, giving power of appeal to the sheriff, which he understood was according to the habit of Scotland.

Mr. DENISON said the sheriff appointed the auditor.

The clause was amended by inserting the word "consumers," so as to read "any three annuitants, or ratepayers, or consumers," &c.

On clause 25D,

Mr. RICHARDS wished it to be declared a voluntary sale. The Town Council said it was a voluntary sale—all the evidence showed that it was in fact a voluntary sale; and he said that the compulsory sale, which was the first suggestion that appeared in that clause, formed no part of the agreement, and ought to be struck out.

Mr. DENISON: No; you must either take the agreement as it stood last year, without the clause, or take the clause, giving you a more distinct chance of its being put as a voluntary concern. If you pass the bill without the clause, then it will be valued as a compulsory purchase under the agreement in this bill, and that is more a disadvantage for the opponents than for us.

The CHAIRMAN said the agreement provided for its being left to the arbitrator, Mr. Lloyd; and the referee himself put it in the clause, which the committee were prepared to pass as it stood.

On clause 25E,

Mr. RICHARDS said in the case of the non-settlement by the arbitrator of the annuities, it was proposed that they were to be based upon the scale of the last dividend; and that until the dividends were declared they were to receive payments upon the previous dividends.

Mr. BONHAM-CARTER: I do not think so.

Mr. DENISON said it was only an interim arrangement. It was only a temporary gain or loss.

Mr. RICHARDS said it made the basis of the calculation the dividends declared by the company.

Mr. DENISON said that was not so. If it turned out too much it was deducted afterwards.

The CHAIRMAN said the committee would pass the clause as it stood.

On clause 25r, providing that the costs of the arbitration should be borne by the commissioners,

Mr. RICHARDS proposed to strike out "the commissioners," and insert "under the terms of the Lands Clauses Consolidation (Scotland) Act."

Mr. DENISON said that was reversing the agreement.

Mr. RICHARDS said he did not apprehend that the committee were bound hand and foot by the terms of the agreement.

Mr. DENISON said good reason must be shown for altering it. By the Lands Clauses Act, the costs would follow upon less or more being awarded by the arbitrator than the offer. His learned friend went upon the assumption that there was to be an offer made, and the consequence would be that a piece of machinery would be brought in which would upset the agreement.

The CHAIRMAN: The committee will pass clause 25r as it stands.

On clause 36, relating to the area of supply,

Mr. RICHARDS said the companies were at present lighting the suburbs beyond the 500 yards mentioned in the clause.

Mr. DENISON said he would agree to 1500 yards, but that would go beyond the notices.

Mr. RICHARDS: As far as they can go consistently with the notices, they will extend the area.

The clause was postponed to make it consistent with the notices.

On clause 47, the standard of illumination,

Mr. RICHARDS proposed to insert the seven towns clause.

The CHAIRMAN said the committee had considered the clause, and could not allow it. They would leave it at 18 candles.

On clause 53, the guarantee-rate,

Mr. RICHARDS proposed the clause should be struck out.

The CHAIRMAN said the committee had decided to adopt the guarantee-rate.

Mr. RICHARDS said there was another question, whether there should not be some limit.

The CHAIRMAN said the committee had considered that also.

The clause was passed as it stood.

On clause 54, providing that the rate should be imposed on all lands and heritages,

Mr. RICHARDS proposed that all buildings, lands, and dwellings in which gas was not consumed, should be exempted from assessment.

Mr. DENISON said that matter was dealt with under the Police Rates Act. Those lands which did not consume gas would only pay a quarter rate.

After some discussion,

The CHAIRMAN said: The committee think that the public Police Act is sufficient to give any exception or reservation.

On clause 25B, which had been adjourned,

The CHAIRMAN said the committee wished to examine Mr. Barlow in reference to that clause.

Mr. *Barlow* was accordingly recalled, and, in reply to the COMMITTEE, said he conceived that, in the year ending May, 1868, the companies would be able to show a more advantageous balance-sheet than for 1867, owing to having entered into the agreement; and he considered that, both with regard to the altered quality and price of gas, they would be able to make a larger claim for compensation. If that claim was not allowed, it would reduce the valuation to the balance-sheet of 1867. He thought, under the letter, the companies would be bound to the accounts for the year when the agreement was entered into. Under the memorandum he thought the facts would have to be taken as they existed on the 8th of March, 1867; but there would be the natural increase of 10 or 12 per cent. in the consumption of gas for the current year to add.

After a short deliberation,

The CHAIRMAN said that, having considered the further evidence, the committee determined to pass the clause as it stood.

Mr. RICHARDS said he would then suggest that Mr. Barlow should be the arbitrator under the Act, as Mr. Denison had offered.

The CHAIRMAN said the committee would be very glad to see the proposition introduced into the bill.

Mr. DENISON said, if his learned friend had accepted the offer when it was made, there would have been an end of the matter; but, after his evidence that morning, he could not go back and offer it again.

The CHAIRMAN said the committee could not oblige the promoters to put it in.

Mr. RICHARDS said, under those circumstances, he should withdraw from further opposition, in order to reserve his right to appear before another tribunal.

The remaining points having been disposed of, the chairman was ordered to report the bill, as amended, to the House.

Miscellaneous News.

METROPOLIS GAS SUPPLY.

METROPOLITAN BOARD OF WORKS—FRIDAY, JUNE 12.

At the Meeting of the Board this day—Sir JOHN THWAITES in the chair,

Mr. SHAW, pursuant to notice of motion, called attention to clause 4 of the City of London Gas Bill, and clause 108 of the Gaslight and Coke Company's bill, the former clause giving powers to the corporation of the City of London to purchase from any company, and to the company to sell, so far as they supply the City, the undertaking, or any part of the undertaking, of any company, provided the Gaslight and Coke Company (that is the Chartered Company) the City of London Gaslight Company, and the Great Central Company, consent thereto; the latter clause (108 of the Gaslight and Coke Company's bill) purposing to enact that the company (which supplies districts both within and without the City) shall be subject to the provisions of the City Gas Act without as well as within the City of London, and for the purposes of the City Gas Act in relation to the undertaking of the company beyond the limits of the City, the Metropolitan Board of Works shall have all the same rights, powers, authorities, and obligations as are given to or imposed upon the corporation in the City Gas Act, so far as relates to the part of the undertaking of the company beyond the limits of the City. He asked the solicitor whether it was intended by such latter clause that the board should have power to purchase that part of the undertaking of the Chartered Company outside the City, to manufacture gas, and to raise money for the purpose out of the rates, and if not so intended, what would there be to prevent such powers coming into operation, provided the three above-named companies agreed to sell, and the corporation of the City of London agreed to purchase the undertaking within the City, and the Chartered Company agreed to sell the part of the undertaking beyond the limits of the City.

The SOLICITOR was quite clear that the board could not exercise the powers referred to.

Mr. SHAW then asked that after the words "Metropolitan Board of Works" should be added the words "saving the powers of purchase."

The CHAIRMAN observed that counsel was quite clear on the point.

The SOLICITOR stated that there would be no difficulty about the insertion of these words, only the bill had passed into the House of Lords, and their insertion now would necessitate the bill going back into the House of Commons. He further stated that he had not only seen the agent who drew the bill, but also the counsel by whom it was settled, and they were quite clear as to the intention of the bill being what he had stated.

Mr. SHAW would not then proceed further in the matter.

THE WATER SUPPLY BILL.

DEPUTATION TO THE HOME OFFICE.

On Friday, June 12, a deputation attended at the Home Office to urge upon the Government the objectionable character of the bill introduced into the House of Commons by Mr. Clive for improving the water supply of towns. The deputation was introduced by Mr. Beecroft, M.P. for Leeds, and Mr. Bazley, M.P. for Manchester. It consisted of Mr. Miles, the governor, and Mr. Robert Baxter, the solicitor of the New River Company; Alderman Wilson and Mr. Davis, directors of the East London Water Company; Mr. Robert Taylor, a director, and Mr. Phipps, the secretary of the Lambeth Water Company; Mr. G. Brett, a director of the Chelsea Water Company; Mr. Malins, a director, and Mr. Arnold, solicitor of the Birmingham Water Company; Alderman Carter, Alderman Oxley, and Alderman Kitson, of Leeds, and Mr. Cawood, the town-clerk of Leeds; Mr. Gwinnett, of the Cheltenham Water Company; Mr. Taylor, of the Cardiff Water Company, &c., &c. In the absence of the Right Hon. Gathorne Hardy, the deputation was received by Sir James Ferguson.

Mr. CAWOOD read a brief statement containing certain objections to the proposed legislation, and handed in a copy of the same to be laid before the Home Secretary.

SIR JAMES FERGUSON: I may perhaps say at once that Mr. Hardy considers he cannot assent to the principle of the bill, and that it is his intention to oppose it on the second reading. At the same time, I shall be very glad to hear any remarks the deputation may wish to offer.

Mr. BEECROFT said it seemed to him that with that assurance the object of the deputation was answered.

Mr. BAZLEY, M.P.: I may just observe, Sir James, that my constituents at Manchester have spent a million and a half of money upon their water-works, and they are very unwilling to come under the provisions of the proposed measure. We should claim exemption, under any circumstances, from a bill of this nature, and I do not see at present the possibility of a general bill applicable to the subject.

Mr. BAXTER handed in a printed statement in opposition to the bill, and

The deputation having thanked Sir J. Ferguson, retired.

DR. WHITMORE'S REPORT ON THE QUALITY OF THE GAS SUPPLIED IN ST. MARYLEBONE, IN MAY, 1868:—

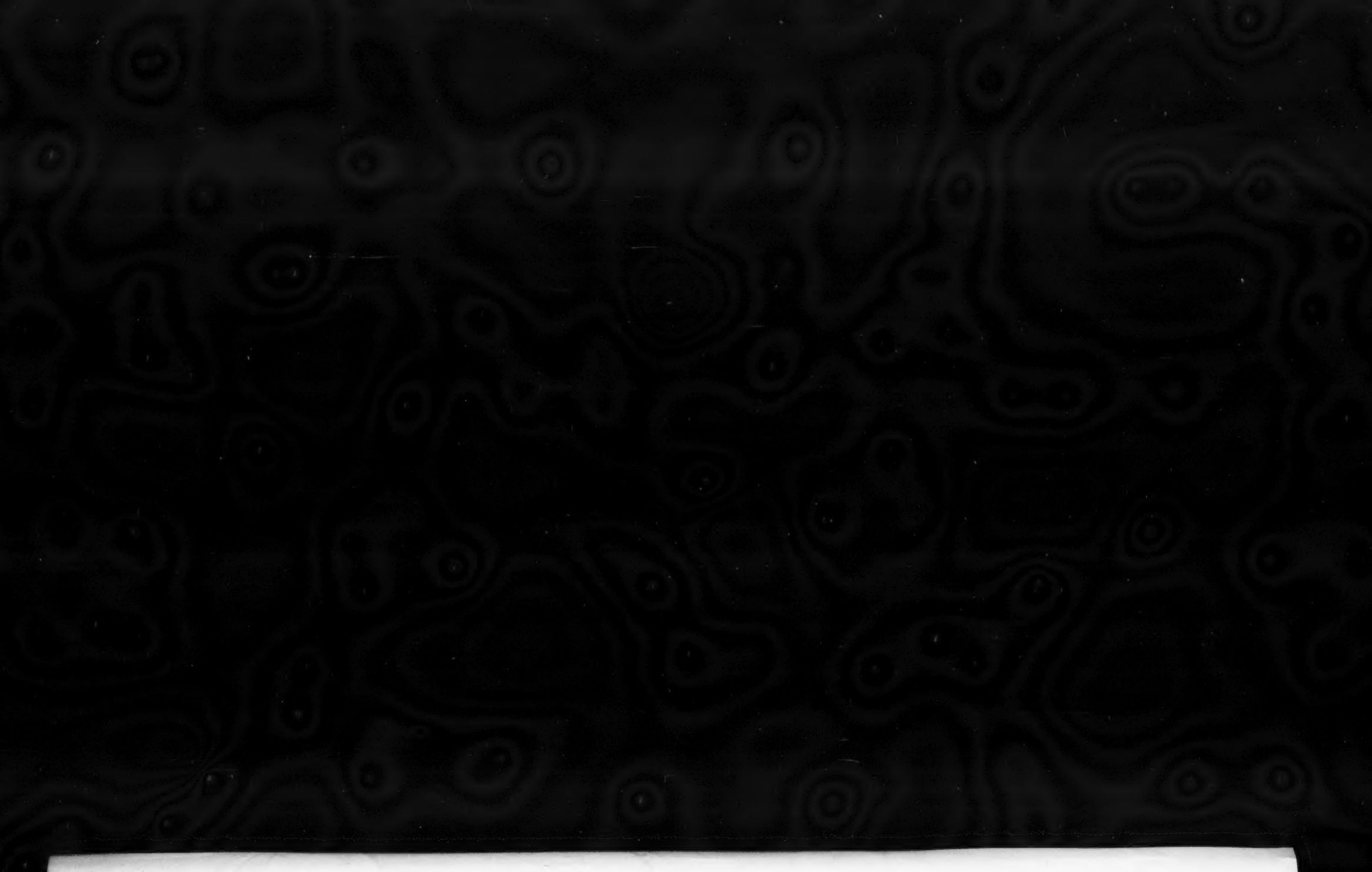
MAY.	Illuminating Power in Sperm Candles.			Mean Pressure in 10ths of an inch.		Mean Amount of Sulphur in 100 Cub. Ft.
	*Mean of Obser-vations.	Highest.	Lowest.	Highest.	Lowest.	
Imperial Co.'s gas . .	14·81	15·50	14·30	22·71	8·76	20·36
Chartered Co.'s common gas	13·60	14·17	12·97	29·53	12·77	24·64
Chartered Co.'s cannel gas	21·02	22·20	20·14	25·45	12·95	20·53

* Each observation consists of 10 readings of the photometer.

The illuminating power of the Imperial Company's gas was characterized by great uniformity during the month; its highest was 15½ sperm candles, its lowest 14⅓ candles, and the mean a little under 15 candles, or rather more than 23 per cent. above the legal standard. Its pressure was satisfactory, and as regards purity, there was an excess of ammonia on 19 days during the month, whilst the result of three analyses showed sulphur to the amount of 20·36 grains in every 100 cubic feet of gas. No sulphuretted hydrogen was ever detected. The common gas of the Chartered Company showed a mean of 13½ candles, three times it exceeded 14 candles, and once only did it fall below 13 candles. An excess of ammonia was observed on 20 days during the month, while the mean of three analyses for sulphur showed the presence of this impurity to the extent of 24½ grains in every 100 cubic feet of gas, or 4½ grains in excess of what is permitted by law. On no occasion was sulphuretted hydrogen detected. The pressure of this gas was uniformly very good. The cannel gas of the same company gave a mean light of 21 candles, being 1 candle in excess of the parliamentary standard, and on no occasion was it less. Excess of ammonia was found in it on 12 days during the month, whilst the mean of its sulphur impurity was half a grain beyond the legal quantity. The pressure of this gas was also very good. The above results were obtained from the gas manufactured by the Imperial Company at their Fulham works, and from the common and cannel gas of the Chartered Company, at their works, in the Horseferry Road, Westminster.

OBITUARY.—Died at Norwich, on the 5th inst., Mr. William P. Green, late of Dartford, Kent, aged 73 years. Mr. Green, who was with Mr. Clegg at Westminster, remained there till 1827, when he removed to Dartford, to remodel the gas-works then recently erected in that town. For nearly 40 years he continued to be the engineer of those works, and was deservedly respected and beloved by many in the profession, and by a large circle of friends beyond it.

STOCKTON CORPORATION GAS-WORKS.—In their annual statement, recently submitted to the Town Council, the Gas Committee report that, "notwithstanding the great depression of trade through their district during the past year, the improvements recently effected in their works have so far diminished the cost of production that they are enabled to recommend a reduction in the price of gas." A further recommendation to increase the salary of Mr. C. Woodall, their engineer and manager, by £100 per annum, was unanimously adopted.

RETIREMENT OF MR. JOSEPH BRADDOCK.—This gentleman, who for thirty years has been the successful manager of the York Gas-Works, has resigned that position, and has joined the firm of Messrs. Newton and Braddock, Globe Meter-Works, Oldham.

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